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CONTENTS—See page VII.

Astronomical Photography.

Hints to Amateurs Regarding Apparatus and Methods of Working.

By ALEXANDER SMITH.

III.—Development of Plates.

THERE are no operations in connection with photography which admit of such varied methods of treatment as the development of dry plates. When these were first introduced, the available developing agencies were confined to pyrogallic acid and ferrous oxalate of potash, but year after year has added to the number, and at the present time a beginner is well nigh bewildered with the variety of formulæ which he finds set down for his guidance in modern photographic textbooks. In addition to the long list of what may be regarded as standard solutions, platemakers issue special formulæ, which may presumably be supposed to give better results than any other for their particular brand of plates, while the fact remains that for all ordinary purposes a good standard solution will satisfactorily develop almost any reliable bromide of silver plate on the market. Many workers confine themselves to one make of plate, which they develop with a favourite formula, and, where the results are all that could be desired, the best advice that could be given is to adhere to them, as they become acquainted by experience with all their little peculiarities, which they are able to turn to the best advantage. It is not so much a question of using any special developer for the plates of any particular maker, as of *varying the details of treatment for different classes of subjects*. Those engaged at astronomical work have to deal with objects of a very diversified character—from the noonday sun to the faintest class of nebulæ. In the one case the result aimed at is to obtain detail on a brilliantly lighted surface, and in the other the outlines of the merest trace of luminosity projected on a very slightly darker background.

For photographs of the solar image a slow plate should, as already indicated, always be selected, and the same remark applies to lunar and planetary work where the driving arrangements admit of giving the requisite exposure. A developer made up to any standard formula may be employed, but with strongly lighted subjects a weak solution will be found to give more satisfactory results than one of normal strength, the plate being allowed to lie a proportionately longer time in the bath. After carrying out many experiments the writer gives preference to a glycin developer, which has many excellent properties. It is always ready for use with the simple addition of water, and the same solution may be used repeatedly. It does not stain the hands, has no injurious effect on the skin, and keeps indefinitely. It admits of great latitude in exposure, and for all scientific work where it is desired to secure soft and delicate detail it is unsurpassed. It may be used with equal success for the development of negatives, lantern slides, or gas-light papers. It does not, however, possess the vigour of pyrogallic acid or metol, and, consequently, the duration of exposure should always be ample, but, on the other hand, a satisfactory negative can be quite readily obtained, although the normal exposure has been very greatly increased. The point to be kept in view is that the developing agent must be of a suitable strength to take up the work where the action of light left off, and if an exposure of 10 or 20 times the normal amount has been given, a satisfactory negative can be quite readily obtained with a glycin developer by employing a diluted, or, what is, perhaps, more preferable, an old solution which has previously developed several plates. Developing agents, such as pyrogallic acid, do not admit of the same latitude in exposure, and, if toned down by the addition of bromide, the effect is hard and delicate detail is lost.

The following formula, which the writer has used for a number of years, can be confidently recommended :—

Water	18 ounces.
Sulphite of Soda	1,090 grains.
Potash Carbonate	2,270 ,,
Glycin	1 oz. bottle.

Dissolve in hot water in the order given. When cold the solution should be filtered and put into well-stoppered bottles. For use, add three ounces of water to one of the concentrated solution for ordinary work, and about five ounces of water for lantern slides or gas-light papers. Certain brands of the latter require the addition of a little bromide, but for other purposes it may be dispensed with, or, at all events, used very sparingly. Solutions which have become slower in action after developing a few plates should not be thrown away, as these may be afterwards utilised in cases where the normal exposure can be readily increased, and, as a practical illustration of the keeping

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qualities of the developer, it may be pointed out that, with the exception of the photographs of Venus, all the plates required to produce the necessary enlargements for the lunar and planetary illustrations accompanying the previous paper were developed with a solution which had been several times used 18 months previously.

In cases where it is desired to secure delicate detail on a plate which has been exposed to a brilliant light, such as that of the sun's disc, and also in cases where the object presents strong contrasts, the plate should be kept in a very weak solution until a faint image is just visible, which will probably require an hour or more. The strength of the developer may then be gradually increased, the requisite amount of density being finally obtained by using a bath of normal strength. The weak solution may be conveniently kept in an old-fashioned collodion dipping bath fitted with a light-proof cover, and afterwards transferred to the usual developing dish, and treated as described. It must be kept in view that no amount of soaking will bring out detail on a plate which has been under-exposed. The exposure in all cases should be ample, and there is, consequently, behind the developer, a reserve of stored up energy, which can be brought into action as required.

With a negative full of detail which is too delicate for the purposes of reproduction, the contrast between the "high lights" and "shadows" may be increased by taking a positive from the negative by contact or by the camera, a much longer exposure than usual being given to a correspondingly weaker light. On the other hand, where less contrast is required, the light is increased and the exposure reduced.

To obtain photographs of faint stars the exposure necessary is so protracted that the methods employed must be such as to secure impressions of the largest number on a given area of the plate in the shortest time, but in the case of stars and diffused nebulosities showing little detail in the shape of structure nothing is sacrificed by having recourse to methods which admit of the exposure being largely reduced at the expense of getting harder effects. For such subjects the most rapid brand of plate should, therefore, be used in conjunction with a vigorous developer. Metol will be found to give cleaner negatives than pyrogallic acid, but if used frequently it sets up an irritating action on the skin, unless the precaution is taken beforehand of rubbing the fingers with vaseline. The following formula has been found to give good results :—

Water	20 ounces.
Metol	75 grains.
Sulphite of Soda	10 drams.
Carbonate of Soda (crystals)	14 ,,
Bromide of Potassium ...	8 grains.

The water should first be heated, and the ingredients dissolved in the order given. The keeping qualities of metol are not equal to those of glycin, and a smaller quantity should be made up at a time.

The plate should as far as possible be covered during the entire process of development, which may be continued until the film has very appreciably darkened in colour.

If the negative after being fixed is carefully examined it will frequently be found that in addition to the well-defined stellar points there are numerous impressions of smaller stars which are little more than visible, and are too faint for printing purposes. If by intensifying the negative the density of these faint images can be increased, a result similar to that which would be obtained by increasing the exposure is secured, and if the following method, which differs only in one particular from that given in photographic text-books, is employed, the exposure necessary to bring out a given amount of detail will be reduced by at least one-half, and only those who have spent many a cold winter night at a guiding telescope can appreciate what this means. After the plate has been fixed and thoroughly washed, but *before being dried*, it is bleached in a saturated solution of bichloride of mercury in the ordinary way. It is again carefully washed and placed in 10 ounces of water to which *one* drop of strong ammonia has been added. It should be allowed to lie in this solution for about an hour, when two additional drops of the alkali may be given, and after a shorter interval the strength of the solution may be further increased if the original colour of the film has not been completely restored. If 10 or 15 drops of ammonia are added at the outset, as is usually recommended, the result will be much less satisfactory, a remark which also applies to attempts to intensify a negative after it has been dried.

The accompanying photograph of a portion of the Milky Way in the vicinity of Beta Cygni is reproduced as an example of the amount of detail which may be obtained with an exposure of two hours by developing with metol, and afterwards intensifying the plate in the way which has been described. It was taken with a $5\frac{1}{4}$-inch lens of 22 inches focus, and an examination of the original negative shows that the greater portion of the region embraced by the photograph exhibits large extensions of faint nebulous matter, broken up here and there by well-marked, irregularly-shaped dark channels, which appear to be associated with streams of small stars.

The method of developing and intensifying a plate here referred to is, however, not applicable to strongly-lighted subjects showing structural detail, and more especially when the object is much brighter at one part than at another. The great nebulæ in Orion and Andromeda may be given as noted examples. If forced development is resorted to in such cases with the view of securing impressions of faint stars and outlying wisps of nebulous matter, the image will have become so dense at other parts, which have received a much greater amount of light, that all detail will be effectually obscured. Exposures made on objects of this class should be developed on the lines recommended for solar work, viz., by using a very weak solution at the outset, allowing plenty of time, and gradually increasing the strength of the developer as the image gains in density.

By careful manipulation it is possible to reduce satisfactorily the denser portions of such negatives by the local application of a reducing solution as described in a previous paper, but it is a matter of opinion how far such treatment may be permissible when dealing with objects of a nebulous character, as there is great risk of introducing detail which has no objective existence.

Another method may be employed to which less objection can be taken. A positive may be made from the negative by contact, and after an exposure, suitable for the parts which are less dense, has been given, a piece of cardboard, with an aperture somewhat smaller than the dense part of the film, is placed over the negative, which is then exposed a second time to the source of light, care being taken that the cardboard is kept moving during the operation, otherwise the shadow of the aperture would appear on the plate. If the dense part of the image increases gradually up to the centre a third exposure may be given with a screen having a smaller opening. From the positive thus obtained another negative may then be taken.

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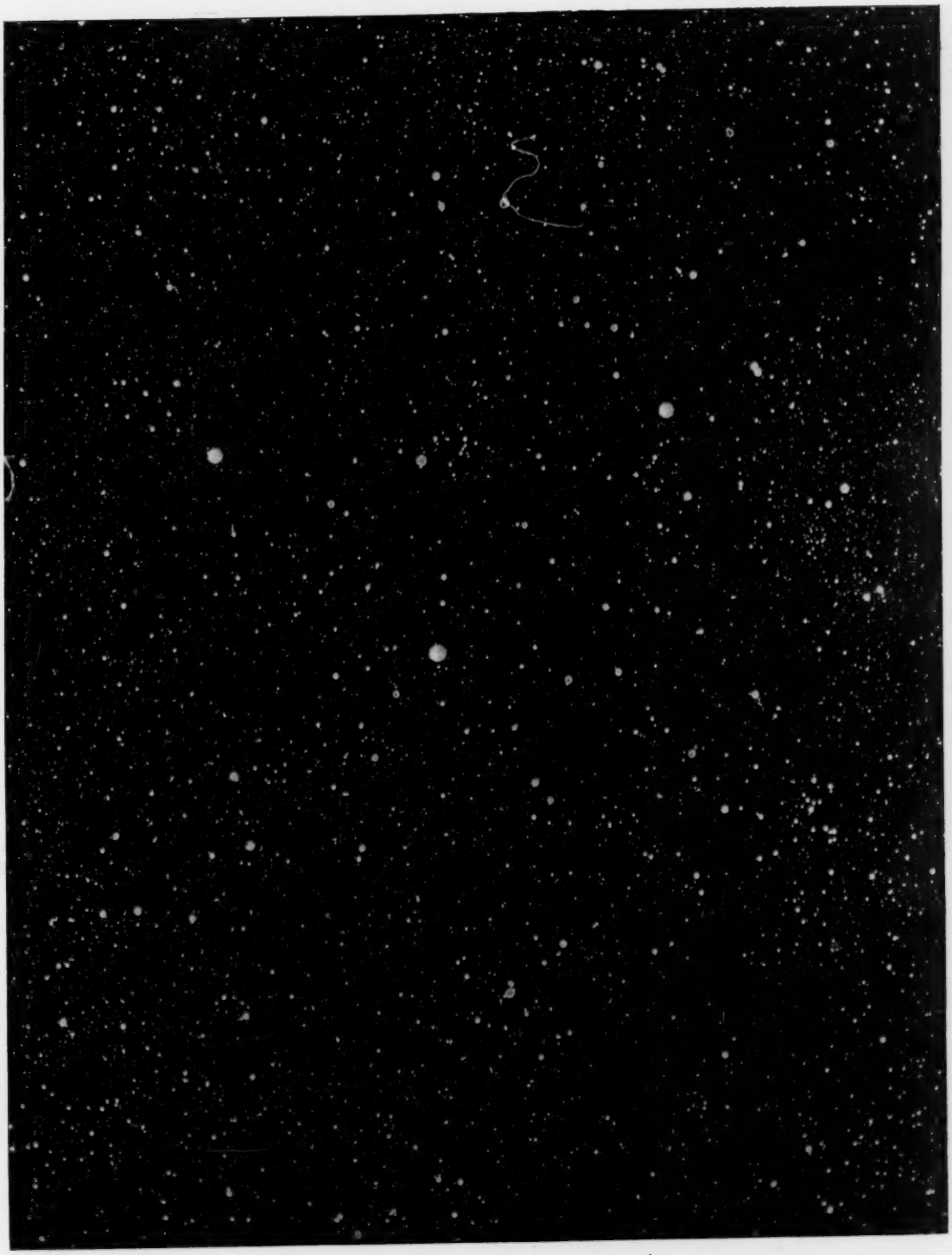

Photograph of the vicinity of Beta Cygni, taken by Alexander Smith. Exposure two hours.

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ENLARGING.

If astronomical photography is to be seriously engaged in, provision must be made for enlarging the original negative, in order that the details of small objects may be shown on a larger scale. The usual method of projection by a lantern is unsuited for delicate astronomical work, and an enlarging camera, similar to that shown in dealers' catalogues, should be employed. These are provided with a long bellows body having a division at the centre for the support of the lens. The front portion should be fitted with carriers suitable for the various sizes of plates there may be occasion to use. The other end should be provided with a focussing screen of a suitable material, and a dark-slide with carriers to take whole, half, and quarter plates. Almost any lens which gives a perfectly flat field when stopped down may be employed. The negative should be covered with a piece of ground glass to diffuse the light, and the whole arrangement placed in front of a window. Slow plates should be used, and it is strongly recommended that these be developed with glycin as previously described.

If the enlarging operations can be carried out in a dark room a camera may be dispensed with altogether. Under such circumstances it will only be necessary to place the negative in an opening in the window, while a baseboard with a support for the lens, and another for the plate, or paper, as the case may be, is all that is required in the shape of apparatus.

Further details need not be entered into here, as these may be found in any photographic text-book, but there is one feature in connection with enlarging, which may be brought under the notice of those engaged in scientific work. If it is desired, for example, to enlarge a small image up to, say 16 diameters, and if this is done at one operation, the grain of the plate will be so obtrusive that there may be a difficulty in some cases in mentally separating the objective details of the image from effects which are spurious. No silver image will bear direct enlargement to the extent in question, and to get the best results this should not be carried further than two diameters at one operation. Four exposures are, therefore, necessary, a positive and negative image being used alternately. The advantage of this method will be at once apparent. Instead of spreading the original image over an area 256 times in extent, a fresh film with the requisite amount of density is obtained at each exposure.

The Gypsy Moth in America.

A curious instance of the adjustment of a newly introduced pest to its surroundings is reported in the last proceedings of the Biological Society of Washington. In the year 1868 some breeding experiments were being made in the Washington Laboratory with the European "gypsy moth." By some accident an "egg mass" was lost—got loose in fact. The consequence was that in the next year Massachusetts found itself faced with a gypsy moth invasion. After spending £200,000 in fighting the insect, the State of Massachusetts gave up the task, and the moth immediately began again to gain ground. Last year the State appropriated another £60,000 to be spent during the following three years in a new scientific attempt to stem the ravages of the moth. Of this sum £2,000 is being spent in the introduction of the parasites which in Europe prey on the moth, and from Sardinia 2,500 parasite-infested larvæ have been introduced. Developments are now being anxiously awaited. The gypsy moth is attacked by American parasites, but it seems to be able to deal with them better than with the European variety, and its own vitality is greater in the New World than the Old.

The Royal Society Soiree.

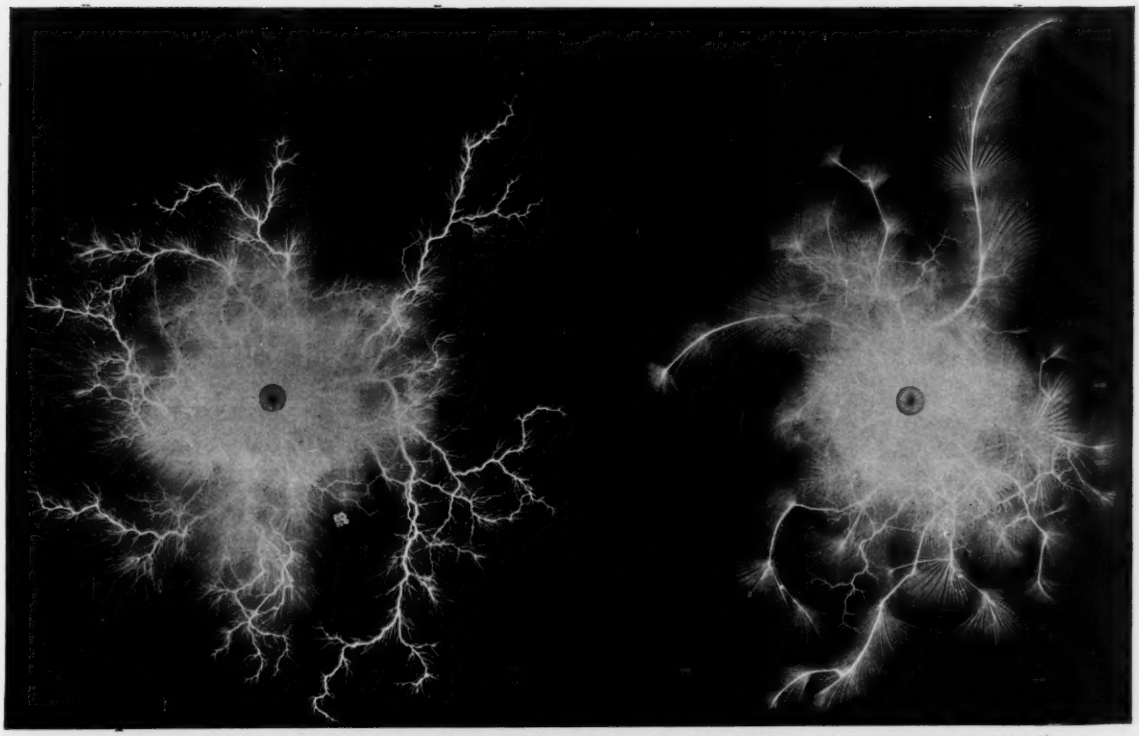
THE first of the two scientific soirées annually given by the Royal Society in their apartments at Burlington House was held on May 9 last, and attracted a representative gathering. The programme of exhibits, embracing as it does on these occasions something from practically every department of science, marking either novelty or progress is, naturally, of too extended a character to permit more than a brief notice. Allusion may, however, be made to a few specially noteworthy features, while we are privileged at the same time to provide the welcome supplement of a selection of illustrations.

The astronomical exhibits were particularly interesting and admirably shown, the use of the "linolite" system of electric lighting being effectively drawn upon to illuminate the series of transparencies. Father Cortie, of Stonyhurst, sent his photographic plates illustrative of the total solar eclipse of 1905, August 30, taken at Vinaroz, on the coast of Spain. In these the chief features are the striking group of prominences, the arches and a vortex ring over the prominences, bright rays and streamers, and a dark ray and plumes; the latter seem to converge to a position previously the seat of the great sun-spot of February and March, 1905. Eclipse results were also furnished by the Astronomer Royal and Sir Norman Lockyer. The Royal Astronomical Society sent six splendid photographs of the Milky Way galaxy, taken last year by Prof. E. E. Barnard at Mount Wilson, California.

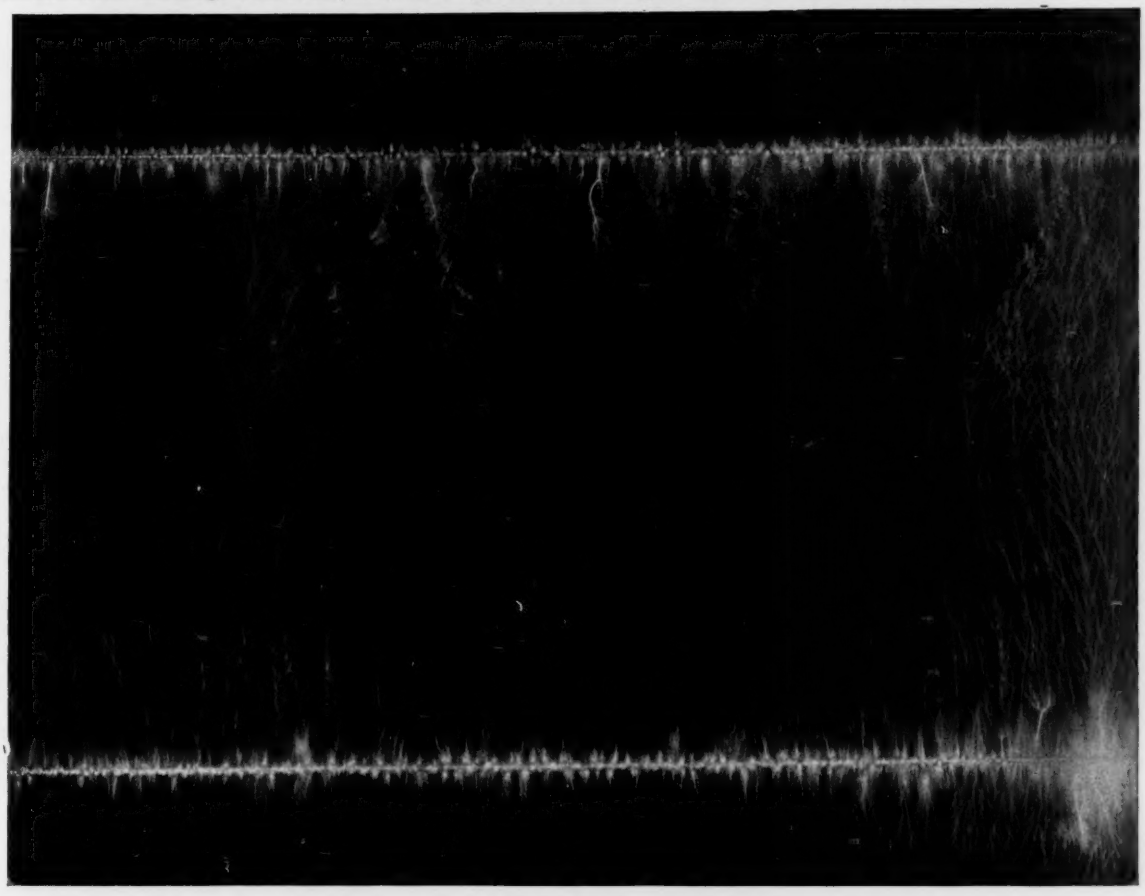
In the department of electricity Mr. Kenneth J. Tarrant's set of photographs of electric discharges at atmospheric pressure and *in vacuo* attracted much attention. In these were seen the results obtained from an interrupted continuous current, and from a high frequency oscillating one, also between parallel conductors, both insulated and bare, of varying capacity and with various condenser conditions. The spiral formation of high frequency discharge, and the same feature in a vacuum a little short of that necessary for the Röntgen phenomena was clearly shown in some of the photographs.

The first of the two photographs reproduced here shows a simultaneous discharge from both poles of a 10-inch coil on to the same plate, the current through the primary being reduced so as to keep the discharge within the limits of the plate. Here is presented the final result of a number of experiments under various conditions, to ascertain whether the marked difference observed in the character of the figures obtained from the two poles of an induction coil was real, or only due to the static induction of the photographic plate itself, or other varying conditions. The second photograph shows an oscillating discharge from a non-magnetic transformer, between two parallel wires of equal size. A spiral twist along the lines of discharge apparently indicates rotation.

Mr. Julius Rheinberg's exhibit of photo-micrographs taken by Dr. A. Köhler with ultra-violet light by means of his specially designed Zeiss apparatus, was of great interest, as well as the allied demonstration by Messrs. Beck, Ltd., of the ultimate microscope resolving power with light of different wave-lengths. For the diatom specimen which was shown in exemplification, a 1-12th-inch oil-immersion objective was used. The beam of a Nernst lamp was split up into a



Simultaneous discharge from both poles, showing characteristic figure attached to each.—*By permission of Mr. K. J. Tarrant.*



High frequency discharge between two bare conductors.—*By permission of Mr. K. J. Tarrant.*

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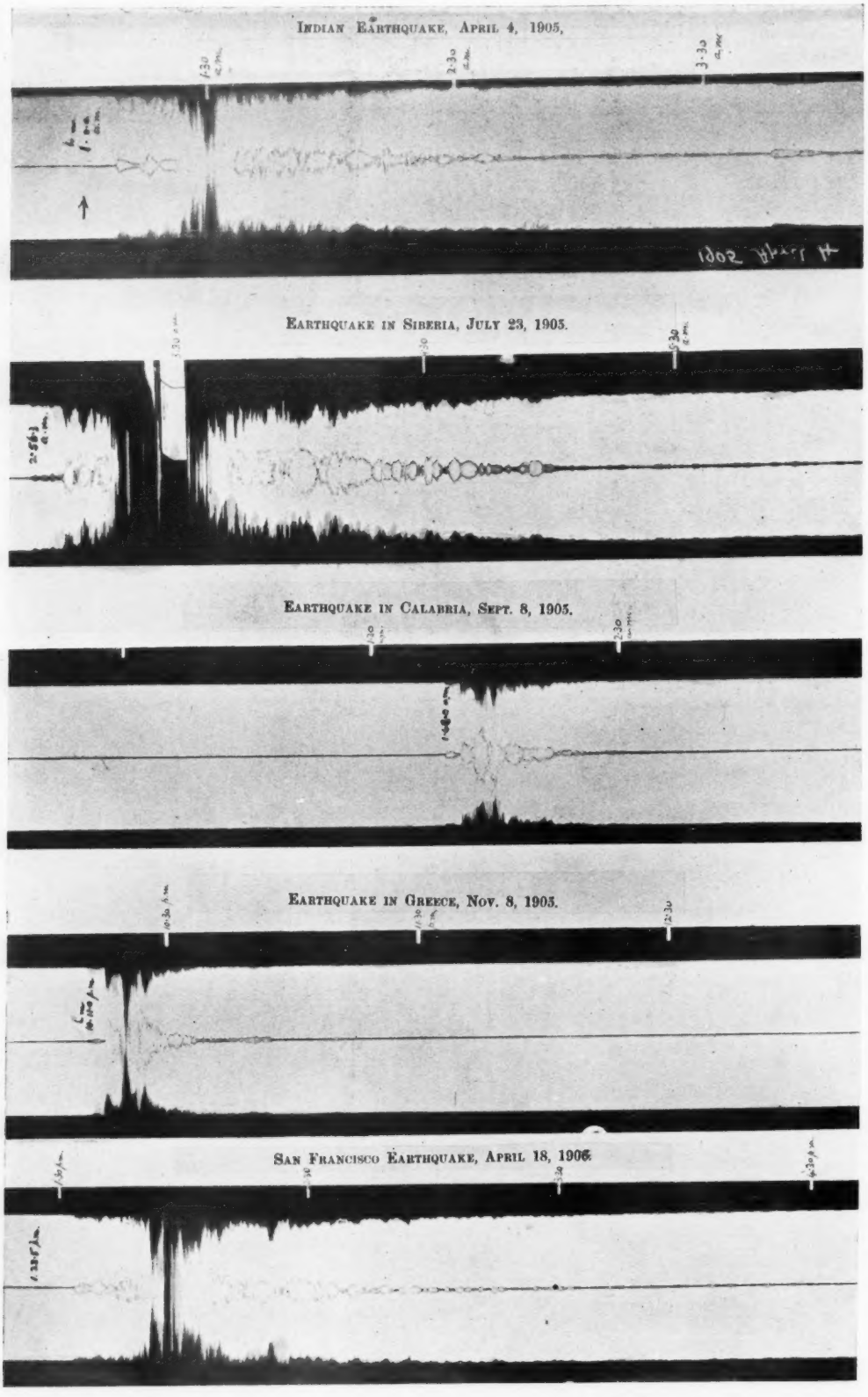
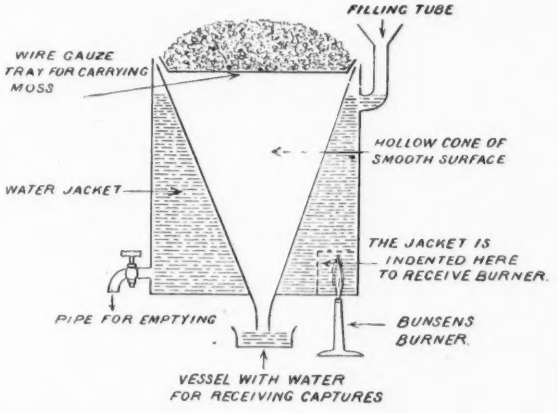

INDIAN EARTHQUAKE, APRIL 4, 1905.
EARTHQUAKE IN SIBERIA, JULY 23, 1905.
EARTHQUAKE IN CALABRIA, SEPT. 8, 1905.
EARTHQUAKE IN GREECE, NOV. 8, 1905.
SAN FRANCISCO EARTHQUAKE, APRIL 18, 1906.

By permission of Prof. Dyson, F.R.S.

brilliant spectrum by means of a Thorp replica grating, the rays of any portion of the spectrum becoming in this way available for the illumination of the object. As the result, whereas the detailed structure of the diatom was revealed with green light, this was not the case with yellow light.

From Prof. J. Milne, F.R.S., and Prof. F. W. Dyson, F.R.S., of the Royal Observatory, Edinburgh, came seismograph records of recent earthquakes, affording suggestive comparative material for the discussion of seismograms relating to the Formosan, Columbian, and San Franciscan earthquakes of this year, as well as of four disturbances occurring in 1905. Two diagrams of the Columbian earthquake, which Prof. Milne showed, had been, it is of interest to note, recorded with a pendulum, weighing in the one case 80 lbs., with a period of 25 seconds, in the other the weight was only a few ounces, with a period of 15 seconds. Both had recorded the period for the large waves as 17 seconds. According to this observer, in the 13 years' interval, 1892-1904, there are records for at least 750 "world-shaking" earthquakes, which may be referred to three periods continuous with each other, and each two-tenths of a year or 73 days' duration.

In natural science the Marine Biological Association were responsible for a small collection of living fishes from the shore and shallow water, illustrating the differences in habit and mode of life adopted by different species. On behalf of Prof. Antonio Berlese, occupant of the chair of Zoology in the University of Naples, Mr. Cecil Warburton brought the former's ingenious


FILLING TUBE
WIRE GAUZE TRAY FOR CARRYING MOSS
HOLLOW CONE OF SMOOTH SURFACE
WATER JACKET
THE JACKET IS INDENTED HERE TO RECEIVE BURNER.
PIPE FOR EMPTYING
BUNSENS BURNER.
VESSEL WITH WATER FOR RECEIVING CAPTURES

apparatus for capturing minute insects, the action of which is seen in the accompanying section diagram. The hollow metal cone is bounded by a water jacket; on the open base of the inverted cone rests a tray made of wire gauze, designed to carry moss or any other material which forms the natural harbouring quarters of small insects. If the water in the jacket is maintained at a temperature of about 70° Centigrade the tiny denizens prefer to quit the moss, but since no footing is obtainable along the sloping sides of the cone they fall into the glass receptacle placed at the apical end of the cone. From there they can be transferred to a dissecting microscope, if required, for identification or examination. Mr. Stanley Gardiner and Mr. H. P. Thomasset's fine series of enlarged photographs of the vegetation of the Seychelles indicated the sharply divisible character of the flora due to soil characteristics.

The Stellar Universe.

By J. E. GORE, F.R.A.S., M.R.I.A.

THAT our *visible* universe is limited in extent there is abundant evidence to show. The number of stars visible to the naked eye is not only comparatively small, but absolutely so; and the number which will appear on the photographic charts of the sky, now in progress, will probably not exceed 100 millions. And even this large number is comparatively small. The richest man in the world is said to possess as many sovereigns; and in a ten-acre field of ripe oats the number of grains of corn probably exceeds the number of the visible stars.* Taking the population of the earth at 1,500 millions, we have the remarkable fact that for every star in the sky there are 15 human beings living on our little globe.

The number of stars visible to the naked eye has been variously estimated. The photometric measures made at Harvard Observatory show the following figures:— Under magnitude 2, 38 stars; under 3.0, 99; under 4.0, 317; under 5.0, 1,020; and under 6.0, 2,865; total 4,339 to the 6th magnitude. The coefficient of increase for each magnitude is about 3; that is, the total number down to any given magnitude is about 3 times the number of all stars brighter than that magnitude. Professor Newcomb thinks that there is no evidence of decrease in this coefficient down to the 10th magnitude. But a diminution in the rate of increase must set in somewhere below the 10th magnitude, for otherwise the number of the visible stars would be considerably greater than it actually is. Taking the total number of stars to magnitude 6.0 as 4,339, and allowing a factor of 3 for the total number to each magnitude below this, I find that the total number down to the 15th magnitude should be about 85 millions, to the 16th magnitude about 256 millions, and to the 17th magnitude—about the faintest visible in the great Yerkes telescope—about 768 millions. It is evident, therefore, that there must be a diminution, or "thinning out," of the visible stars at some point in space. This diminution in the increase probably begins with stars of the 10th or 11th magnitude. Now what is the cause of this decrease in number as the stars become fainter? Is it due to an actual decrease in number as we approach the limits of the visible universe, or is it caused by an extinction of light in the ether of space? The latter seems improbable, for Professor Seeliger finds that stars of the 11th and 11½ magnitude are comparatively few in number near the poles of the Milky Way, but are very numerous in the Galaxy itself. This is also true for fainter stars, such as those seen by Sir William Herschel in his "gages." Photographs give similar results. Dr. Roberts' photograph of the Milky Way in Cygnus shows about 8,500 stars to the square degree, while a photograph taken near the North Galactic pole shows only 178 stars to the square degree, the average for the whole sky being about 2,500. It seems reasonable, therefore, to conclude that if faint stars are apparently few in number near the poles of the Milky

* This I have found by actual experiment on the number of grains on a square foot.

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Way, the real reason is that the stars are *not there*, and that in this region, at least, there is a real "thinning out" of the stars at a certain distance from the earth. It is clear that if absorption of light by the ether had any real, or, at least, appreciable, effect, it would have the same effect in the direction of the Milky Way as in that of the Galactic poles. We must, therefore, conclude that the paucity of stars near the poles of the Milky Way indicates that the stars are really few in number in that direction, and that here, at least, the visible universe of stars is limited. And it seems highly probable, and, indeed, we may say certain, that even in the direction of the Milky Way itself the stars thin out beyond a certain distance, and do not extend indefinitely into space, for if they did, the Milky Way would be much brighter than it is.

Now let us consider what is the probable extent of the visible universe. The faintest stars visible on photographs are probably about the 18th magnitude; that is, about one magnitude fainter than the faintest visible in the Yerkes telescope. Assuming this magnitude, and taking the sun's stellar magnitude as -26.5, I find that to reduce the sun's brightness to that of these faint stars it should be removed to a distance represented by about 12,500 years of light travel. The sun, if placed at the distance of Sirius (parallax $= 0''.37$), would shine as a star of about 2.22 magnitude, or 3.8 magnitudes fainter than Sirius appears to us. From this it follows that Sirius is about 33 times brighter than the sun. Sirius might, therefore, be removed to 5.75 times ($\sqrt{33}$) its present distance and still shine as a star of 2.22 magnitude; and to reduce it to a star of the 18th magnitude it should be removed to 8,241 times its present distance. This would represent a light journey of about 72,000 years. If, therefore, any of the 18th magnitude stars in the Milky Way are suns similar to Sirius, that is, of the same size and intrinsic luminosity, they may lie at a distance of 72,000 years of light travel from the earth. That is, provided that light suffers no extinction in traversing this vast distance. And if similar to our sun, they may be at a distance of over 12,000 years' journey for light.

There seems to be evidence, however, that the greater portion of the light of the Milky Way does not come from these faint stars, but from stars considerably brighter. Mr. C. Easton finds from an examination of a photographic plate of a very brilliant region of the Milky Way to the south of the bright star γ Cygni (a region including 25 Cygni), that about half the total light of the Milky Way in this region comes from stars of the 9th to the 12th magnitude. From this he concludes that neither the bright telescopic stars (6th to 9th magnitude) nor the very faint stars (12th to 14th magnitude) have any great influence in producing the light of the Galaxy. From an investigation of a much fainter portion of the Milky Way he finds the same result.* This agrees with my own computations of the total brightness of starlight, which show that the maximum amount of light comes from stars of the 9th to 12th magnitude.† From further investigation Easton thinks it "extremely probable that the great majority of the fainter stars of the Milky Way—so far as their existence is revealed to us by photography or direct vision—are not much more distant from us than the stars of the 9th or 10th magnitude, at least, in the regions to which our researches have extended."‡

Professor Newcomb thinks that there is evidence to show that the stars of the Milky Way are probably situated at a distance between 100 million and 200 million times the sun's distance from the earth. These distances correspond to 1,579 and 3,159 years of light travel. Placed at the greater of these distances, I find that the sun would be reduced in brightness to a star of the 15th magnitude.

There seems to be evidence that the faint stars of the Milky Way have spectra of the Sirian type. Supposing, with Easton, that the fainter stars of the Milky Way are of the 12th magnitude, and, further, that they are comparable with Sirius in size and brightness, I find that their distance would be represented by about 4,600 years of light travel. But Sirius is, perhaps, a larger body than the average Galactic star. Its mass is about two and a half times the mass of the sun, and its brightness about 33 times greater. Possibly the stars of the Milky Way may be much smaller. Professor Kapteyn finds from an investigation of the probable distances and brightness of a number of stars of various magnitudes that in a volume of space containing two millions of stars of the same luminosity as the sun there would probably be about half a million brighter than the sun, and about 12½ millions of smaller luminosity; that is, out of a total of 15 millions of stars, about 12½ millions would be smaller than our sun.

To reduce the sun to the brightness of a star of the 12th magnitude it should be removed to a distance of about 790 "light years." To reduce the following stars to the 12th magnitude they should be removed to the distances represented by the light years given in the fifth column :—

STAR.	Magnitude.	Parallax.	Distance. Light Years.	Distance to which Star should be moved to reduce its light to 12th magnitude.
		"		Light years.
Sirius.. ..	−1·58	0·37	8·8	4600
α Centauri ..	0·06	0·75	4·34	1086
Capella ..	0·21	0·08	40·7	9300
Procyon ..	0·48	0·325	10	2030
α Aquilæ ..	0·89	0·231	14·1	2360
Aldebaran ..	1·06	0.107	30·4	4650
η Cassiopeiæ ..	3·64	0·154	21·1	1000
τ Ceti	3·65	0·31	10·5	500
70 Ophiuchi ..	4·07	0·16	20·3	794
o_2 Eridani ..	4·48	0·166	19	651
δ Equulii ..	4·61	0·071	46	1416
ε Indi	4·74	0·28	11 6	309
1830, Groombridge ..	6·47	0·15	21·7	278
Lalande, 21,185..	7·60	0·344	9·4	72
Kruger, 60 ..	9	0·271	12	48

Omitting the last two stars, which seem to be small bodies comparatively near the earth, we see that the distances of the others would range from 278 to 9,300 years, if all were reduced in light to a star of the 12th magnitude. The average of these is 2,921 light years. As these stars are of various sizes and brightness—their "relative brightness" compared with the sun ranging from 0.122 to 128.33*—we may, perhaps, assume that they represent nearly all classes of stars, and that the average distance of 12th magnitude stars is about 3,000 light years.

If we assume that the stars of the Milky Way are much smaller than Sirius, say one-half the mass of the sun, or one-fifth of the mass of Sirius, I find that the distance of 12th magnitude stars would be—if of the

* "KNOWLEDGE," July, 1903. † "KNOWLEDGE," August, 1901.
‡ "KNOWLEDGE," August, 1895.

* See my paper on *The Relative Brightness of Stars* in Monthly Notices, R.A.S., January, 1905.

same density and surface luminosity as Sirius—about 2,700 "light years." Let us assume with Newcomb that the outer boundary of the Milky Way is at about 3,000 light years, and see what average distance this will give between each pair of stars, on the supposition of an equal distribution of stars in a globular space: We know, of course, that the visible stars are *not equally distributed*, but the computation will give the average distance between any two adjacent stars. Assuming a total of 100 millions, and that each star is placed at the angle of a tetrahedron,* I find that the average distance between two stars would be about 21.24 light years. This corresponds to a parallax of 0″.153. Now I find that the average parallax of 20 stars, for which a fairly reliable parallax has been found is 0″.247. If we exclude those stars with a parallax of over 0″.3—which may, perhaps, be considered as exceptionally close to our system—we have 13 stars with an average parallax of 0″.155.

From a consideration of the proper motions of two groups of stars, one of 206 stars of mean magnitude 5.7, and mean proper motion of 0″.31 per annum, and another of 199 stars of mean magnitude 8.1, and mean proper motion of 0″.304, Mr. J. G. Porter finds "the average parallactic motion" of all the stars to be 0″.185; that is, the annual apparent motion due to the sun's motion in space. Taking this annual motion as four radii of the earth's orbit, that is, four times the sun's distance from the earth—a quantity probably near the truth—the mean parallax of the stars considered would be 0″.046, or about 70 years' journey for light. But judging from their magnitude these stars would not be among our nearest neighbours in space.

With a distance of 21.25 light years between two stars at a distance of 3,000 light years from the earth, I find that the apparent distance between such stars in the Milky Way would be about 24 minutes of arc, and as the faint stars in the Galaxy are, on an average, much closer than this, it seems highly probable that the stars composing the Milky Way are much nearer to each other than a distance of 21 light years, and this the crowded appearance of the Galaxy would lead us to suppose.

If we take the average width of the Milky Way as 20°, I find that the volume of space contained by lines drawn from the eye to the edges of the Galaxy is about 0 1767 of the volume of the whole sphere. Hence, with an equal distribution of stars, the Milky Way should contain about 17½ millions of stars. Now Dr. Roberts' photograph in Cygnus shows about 8,500 stars to the square degree. This would give a total of about 61 millions for the whole of the Milky Way. But as this is rather a rich part of the Galaxy the total may not exceed 40 or 50 millions; that is, two or three times that due to an equal distribution of stars. This agrees with some experiments made by Mr. Gavin J. Burns, who finds that the average luminosity of the Milky Way is from two to three times greater than that of the rest of the sky.†

Assuming that the Milky Way contains a total of 50 millions of stars, and that its limits lie between 1,500 and 3,000 "light years," I find that its volume would be about 0.1546 of the sphere having a radius of 3,000 light years. This would give an average distance between two adjacent stars of 14.36 light years. On this hypothesis the Milky Way would have a considerably greater extension in the line of sight than at right angles to that line. If we suppose that its thickness in the line of sight does not on the average exceed its apparent thickness; that is, that its cross section is roughly circular, and assuming that its mean distance is about 2,300 light years, I find that its diameter would be about 800 light years, its nearest and its farthest parts being at about 1,900 and 2,700 light years respectively. In this case the average distance between the component stars would be about 10.7 light years.

In the globular cluster ω Centauri, an enumeration made from photographs by Professor and Mrs. Bailly gives a total of 6,389 stars on an area of about 30 minutes square. This gives 25,556 stars to the square degree, and if the distance of ω Centauri is at all comparable with that of the Milky Way its component stars must be much closer than in any part of the Galaxy. The same may be said of the smaller Magellanic Cloud, which has about 28,000 stars to the square degree.

Easton thinks that the stellar universe is of "a fairly thick lens shape filled with stars which are much more closely congregated near the edges than near the centre of the lens." Professor Newcomb's views are somewhat similar. But this is returning to Sir William Herschel's "disc theory," and it seems doubtful whether such a conclusion is warranted by the evidence. As is well known, this disc theory was abandoned by Herschel himself in his later writings. I have never seen any answer to the argument against the disc theory advanced by me in "The Visible Universe" (pp. 241, 242). The argument is as follows:—As the thickness of Herschel's supposed disc extends on both sides of the earth beyond the theoretical distance of stars of the 9th magnitude, the stars of this magnitude should be as numerous in the direction of the Galactic poles as in the direction of the Milky Way itself. But this is not the case. Argelander's maps show that 9th magnitude stars are more numerous in the Milky Way than at the Northern Galactic pole in the ratio of 2½ to 1. Even the stars visible to the naked eye show a marked tendency to aggregation on the Milky Way, and Easton finds that the faintest stars of Argelanders' catalogue—about 9½ magnitude—"present, by the manner in which they are distributed, a remarkable correspondence with the luminous and obscure spots of the Milky Way." These facts seem to be inconsistent with the disc theory as originally propounded by Herschel. From the evidence quoted above it seems evident that if the stellar system is in any way shaped like "a thick lens" there must be a considerable crowding of stars along the edge of the disc; that is, in the direction of the Milky Way.

Struve's modification of the "disc theory," namely, a disc of a certain thickness, but of infinite, or, at least, indeterminate, diameter, seems an improbable hypothesis, and one not in agreement with observed facts. Even on this theory our sidereal system is supposed to be limited in the direction of the Galactic poles. If Struve's theory were accepted we should also be obliged to accept his hypothesis of the extinction of light in the ether; for otherwise the Milky Way would be much brighter than it is. With an infinite extension, the Galaxy would shine with the brightness of the sun. The comparatively feeble gleam of the Milky Way on even the clearest nights should, I think, be sufficient to convince the thoughtful observer that its light is *not* due to a vastly extended stratum of stars. Even Sir John Herschel's reflecting telescope of 18½ inches aperture (now far surpassed in space-penetrating power by modern instruments) sufficed in some places to show the component stars of the Milky Way on a *black* back-

* If s be the side of a tetrathedron, its volume is $\frac{s_3}{12}\sqrt{2}$.

† *Astrophysical Journal*, October, 1902.

XUM

ground devoid of any nebulous light. With reference to one of his "sweeps" he says, "The northern end of the zone, though pretty rich in *stars*, is yet quite free from brightness of ground. It is as black as a coal," clearly showing that his optical power could—here, at least—fairly penetrate through the stellar stratum into the starless void beyond.

Photographs of some portions of the Milky Way show the fainter stars as points of light on a black ground devoid of all nebulosity. More powerful telescopes and more sensitive plates will probably disclose the existence of many fainter stars, but all the evidence we have at present seems to point to the conclusion that the utmost limit of telescopic vision will soon be reached, and that the most powerful telescope which man can construct will ultimately show that the stars, even in the richest portions of the Milky Way, are strictly limited in number.

The general aspect of the Milky Way seems sufficient to negative the "disc theory." The numerous convolutions, rifts, and "coal sacks" shown in the drawings of Boeddicker and Gould and in photographs of the Milky Way can hardly be explained by the honeycombed structure of a stellar disc, and one finds it difficult to resist the conclusion that the apparent streams of nebulous light which are seen branching out in many directions from the Galactic zone are really streams of stars and nebulous matter in space, and that the apparent openings or holes, known as "coal sacks," are, in reality, perforations through a stellar stratum of comparative thinness rather than cosmical tunnels of immense length pointing directly towards the earth.

With reference to the clusters and nebulæ, the distance of these objects has not been ascertained; but from the fact that stars, clusters, and nebulæ are mixed up in the Magellanic Clouds in a space which is apparently of a nearly globular form, we may conclude that all these diverse objects may co-exist in the same region of space, and that, consequently, the nebulæ are not, as a rule, farther from the earth than the faint stars seen in the same direction. Photographs of the Magellanic Clouds, taken by the Harvard observers, show that these objects are very rich in small stars. Photographs of the large cloud show about 300,000 stars. This would give about 300 millions for the whole sky, if equally rich. The small cloud seems still richer, as the photographs show about 280,000 stars on an area of about 10 degrees. This would give the enormous total of 1,155 millions for the whole sky, and it is, perhaps, the richest spot in the heavens. Assuming a distance of 3,000 light years, I find an average distance between the component stars of the large cloud of about 9½ years, or more than the distance between Sirius and the earth; and for the small cloud an average distance of about 5 years. It will be seen that both are considerably less than the average for the whole sky, and show that the stars in the clouds are crowded together.

Seeliger estimates that the limits of the Milky Way lie between 500 and 1,100 times the distance of Sirius; that is (the distance of Sirius being 8.8 light years), between 4,400 and 9,680 light years. At these distances the sun would be reduced to the magnitudes 15.7 and 17.4 respectively. As most of the stars in the Milky Way are much brighter than this, and as most of them are, according to Kapteyn, smaller than the sun, we may, I think, reasonably reject Seeliger's distances as excessive. Newcomb's distances are probably much nearer the truth.

Miniature Harmonographs.

By CHARLES E. BENHAM.

ONE of the chief drawbacks of the harmonograph is its cumbersome character and the heavy weights required. By adopting the method described in the January number of "KNOWLEDGE," of making the recorder a needle point attached to a light strip of paper, friction is so far diminished that it is possible to reduce the size of the apparatus, and to make use of weights of not more than 1lb. each. It might be supposed at first sight that the avoidance of friction which this device secures could be attained just as well by counter-balancing the pen lever, but this is not so, for the counter-balanced

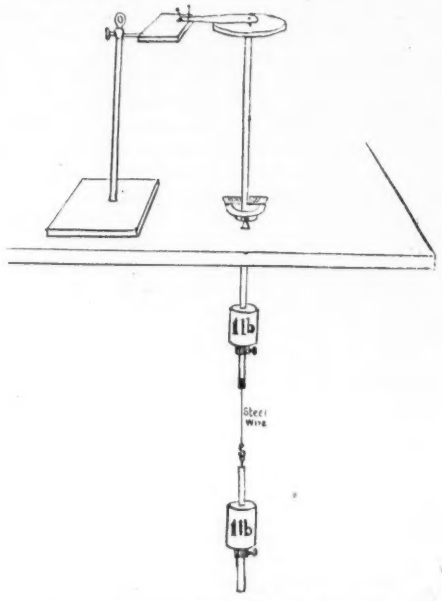


Fig. 1.—Miniature Twin-Elliptic Pendulum.

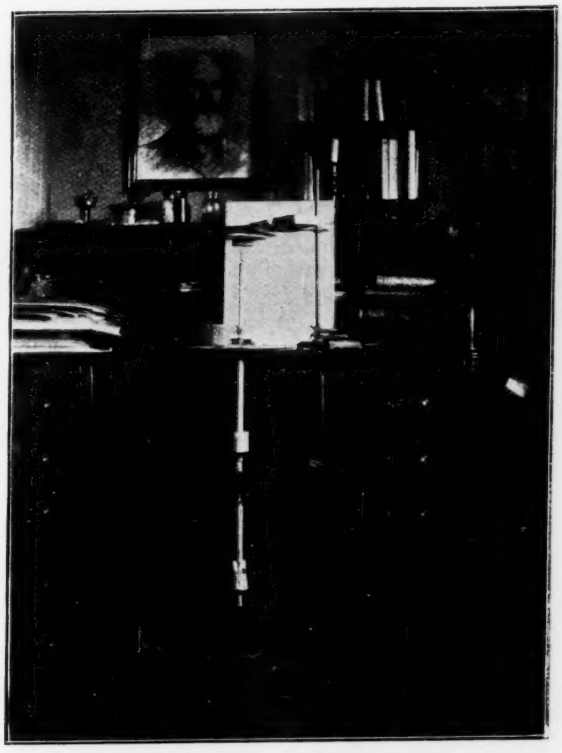
lever if brought so near to equilibrium will bounce, and prove quite unsuitable for carrying the pen that is to record a continuous line.

Fig. 1 shows a miniature twin elliptic pendulum of very simple construction. A pendulum rod, ¼ inch thick, and 20 inches long, is mounted on gimbals at the centre, and passes vertically through a hole of about 2 inches diameter in a firm table. The gimbals are formed by a flat light steel ring, resting on knife edges rising from the table and receiving on its upper surface the knife edges of the pendulum, at right angles to those under the ring. At the top of the pendulum is a flat round table, about 4 inches in diameter. The pendulum weight (1 lb.) slides up and down the lower part of the rod and can be fixed by the perforated nut and screw below it.

The rod terminates in a metal cap in which is centrally fixed, embedded in lead, a hanging thin steel wire (a "first" mandoline string). The other end of the steel wire terminates in a loop to which by means of a brass

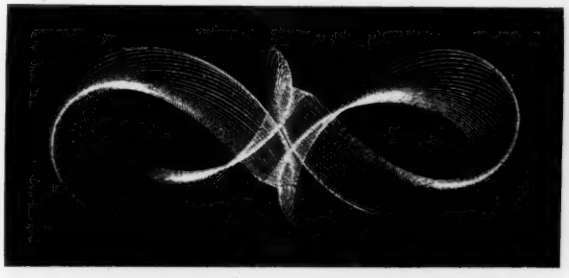
S-shaped hook, a second pendulum rod, about 8 inches long, is attached, this rod also carrying an adjustable weight of 1 lb.

The weights can be cast in the cylindrical boxes used for incandescent gas mantles, the central hole being



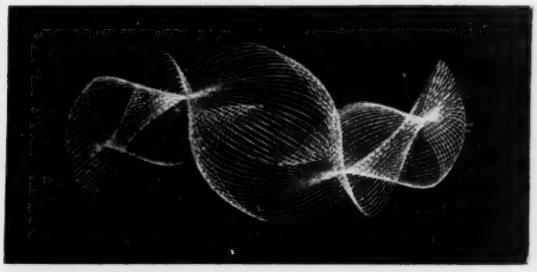
The Miniature Twin-Elliptic Pendulum.

provided for by an upright rod fixed vertically in the mould, which must be quite dry when the melted lead is poured in, or there is danger of the hot metal flying out. A half-inch wooden rod, with a few folds of paper round it, will give a central hole of the right size.



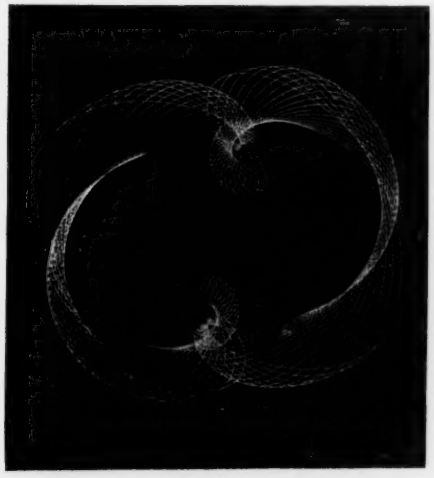
Approximate 1 : 3 harmony (opposed rotation) traced with miniature twin-elliptic pendulum.

The needle to trace the curves should be as fine as possible and about $\frac{1}{4}$ inch long. The fragment is stuck vertically through a strip of writing paper 4 inches by 1 inch, tapered a little at the end which holds the needle-point. A drop of glue holds the needle firmly in position. The other end of the strip is fastened by two pins to a small flat board, supported on a retort stand or other convenient support, so that it can be raised or lowered to the required level. Smoked paper is placed on the pendulum table-top, and when the apparatus is started, the strip, which had been supported by a knitting needle held in the left hand, is allowed to drop upon the smoked surface, where the needle traces the curve described.



Approximate 1 : 3 harmony (opposed rotation) traced with miniature twin-elliptic pendulum.

Enamelled paper, such as is used for "process" illustrations, must be used, and it should be fixed in a little frame, such as a child's drawing slate, the surface being then evenly smoked with the flame of a wax taper, holding the lighted taper horizontally under the paper and moving it to and fro until the whole surface is evenly covered. The frame with the paper still fixed in it is laid on the table top. It requires no clip to hold it, the friction not being sufficient to move it.



Approximate 1 : 3 harmony (concurrent rotation) traced with miniature twin-elliptic pendulum.

To fix the tracings, take the paper from the frame, and brush the back of it with a fixative made of hard white varnish one part and methylated spirit four parts. When dry the smoked surface is fixed and may be improved by polishing it lightly with a clean tuft of cotton wool.

The best figure is the approximate 1 : 3 harmony, of which examples are reproduced. This figure in its different phases gives hundreds of variations. No figure is symmetrical, even though harmonic, unless the

XUM

difference between the two numbers composing the ratio is an even number, such as 1 : 5, 3 : 7, or 3 : 5. On the other hand 1 : 2, 1 : 4, 2 : 3, and any ratio where the difference is an uneven number, give harmonies which are non-symmetrical.

Approximate 1 : 3 harmony (opposed rotation) traced with miniature twin-elliptic pendulum.

To start the instrument hold the rod near the top and give it a slight circular movement followed by a very slight reverse impulse. This will start the two pendulums in opposed rotation. A single impulse will start them in concurrent rotation.

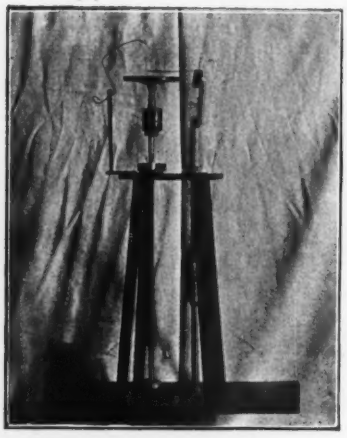


Fig. 2.—Miniature Harmonograph (Tisley type). The paper strip with needle is attached to the pendulum on the right and is supported by a silk thread hanging from the wire on the left, which lowers the needle for describing the curves, the silk then hanging loose. As shown, the weights are adjusted for the harmony 1 : 3.

To tune the instrument, adjust the upper pendulum weight to various positions until an approximate harmony is reached. If the repeat line falls in advance, raise the upper weight a little ; if it lags behind lower the upper weight. The weight on the lower pendulum may be raised and lowered with similar effects, but in a less marked degree, so that it is only necessary to alter it for fine adjustment.

The ratios of the harmonies obtained are thus computed: With concurrent movement the nodes (*i.e.*, loops or points) are inside the figure and their number is the difference of the numbers in the ratio. With opposed movement the loops are outside, and their number is the sum of the numbers in the ratio. For example, if with concurrent rotation there are eight internal nodes, while with opposed rotation there are 14 external loops, $x+y=14$; $x-y=8$. $8+2y=14$, $y=3$, $x=11$, or the ratio is 3 : 11.

Fig. 2 shows an ordinary harmonograph of miniature form, which by means of the paper strip device gives very fine tracings, though the weights are no heavier than those in the miniature twin elliptic. By using a top-weight harmonies of 1 : 3 can be obtained with this little instrument. Two specimens of its work are reproduced.

A similar recorder would probably be very serviceable for seismographs, and for any purpose which involves the registering of minute oscillations.

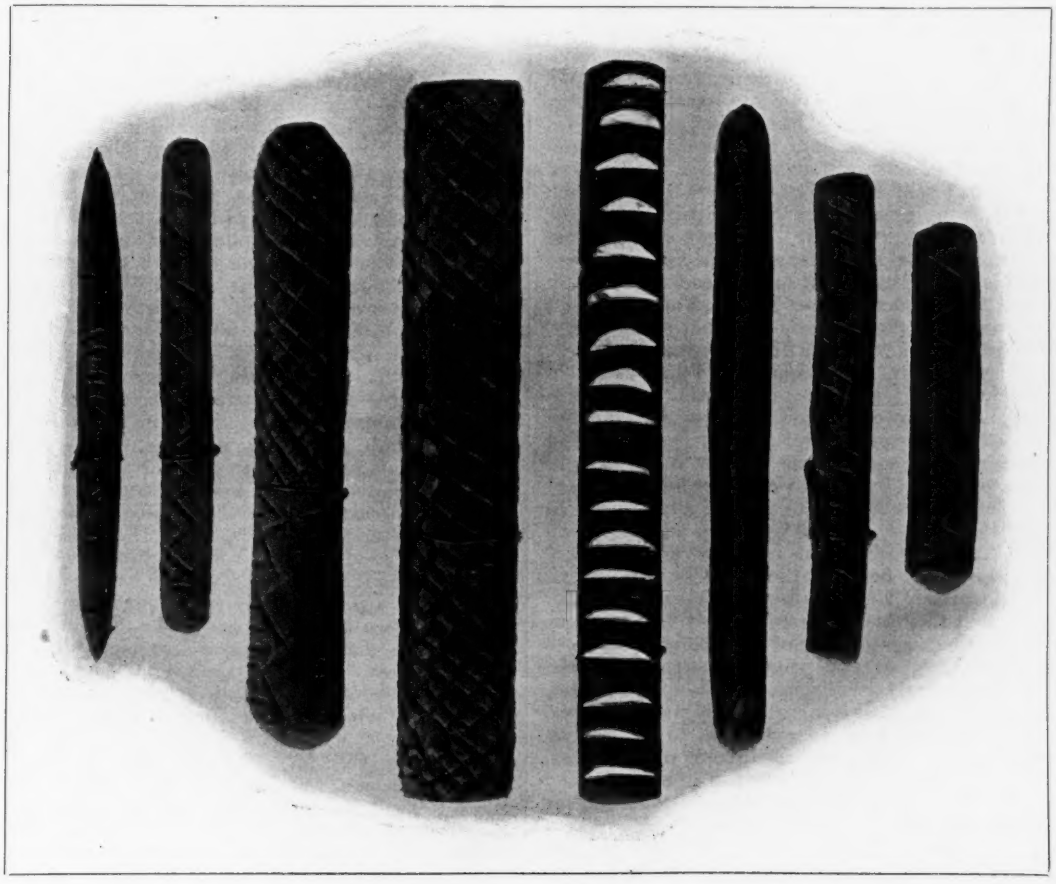
Queensland Message Sticks.

A GOOD deal of uncertainty and a large amount of speculation surround the methods by which the members of aboriginal races communicate one with another. Numerous legends have collected about the so-called message-sticks of the Queensland natives, which have been said to serve the purpose of conveying messages from one part of the colony to another among the natives. Some authentic explanation on the point is supplied by Mr. Walter Roth in Bulletin No. 8—North Queensland Ethnography, which is published by the Queensland Government. Mr. Roth writes :—

"The limited quantity and portability of a native's personal goods offer little or no opportunity for the use of property-marks. If weapons are of the same cut, there are minute, yet sufficient, differences which are recognisable to the owners ; even if similarly ornamented, no two are so alike that they cannot be distinguished. In a general way, each having sufficient for his own wants, and no person having more than another, there is nothing to thieve, and hence, as already mentioned, the levity with which theft, even when it occurs, is regarded. Only in cases of trade and barter, through an intermediary, where it is essential that one individual's goods should be distinguished from another's, is there a necessity for a definite property-mark, this taking the form of a so-called 'letter-' or 'message-stick.' Under such circumstances, the 'stick' may be put into use as follows :—Charlie, residing at Boulia, wants, we will say, some pituri, but being prevented by sickness or some other cause from going himself, sends some relative or friend Peter to the nearest market, on the Mulligan River, to get some for him, and gives him a 'message-stick.' Arrived at last at his destination, Peter is asked his business, tells who has sent him, hands over the 'stick,' and establishes his *bonâ fides*. The bagful of pituri being at last forthcoming, the vendor returns the 'stick' to Peter, but not before taking careful mental note of it,

so as to be sure of recognising it again. Peter returns at last to Charlie at Boulia, and delivers up both pituri and stick. It now remains for Charlie to pay for the pituri with spears, boomerangs, &c. If he can prevail on Peter to take a second trip, all well and good, but if not, as is usually the case with so long a journey, he either proceeds himself or sends another messenger with the goods and the identical 'message-stick' as before. He, or the second messenger, arriving at the Mulligan, finds the vendor, and gives him the spears, boomerangs, &c., together with the 'stick.' Recognising the latter, the seller accepts the various articles in payment for the bagful of pituri which he parted with some few weeks previously, knowing now that he has been paid by the right person, probably personally unknown to him—*i.e.*, the sender of the original 'stick.'

"I am absolutely convinced that the marks on the so-called letter- or message-sticks do not convey the slightest intimation of any communication, in the ordinarily accepted sense of the term, from sender to receiver; this view is based mainly on the grounds that the same message may accompany different sticks, the same stick may accompany different messages, and the stick may bear no marks at all. I have been given a stick to take with a certain message to another district, and purposely mislaid it temporarily, in order to secure another specimen. Again, 'second-hand' sticks may be used over and over again by strangers, who certainly have had no knowledge of the original manufacturers. Sometimes a broken twig is sufficient, without any incisions whatever, and I have often seen a piece of tea-tree bark, or even a rag, just tied round and round with twine, to constitute the so-called letter. To put the matter plainly, the message is taken verbally, the stick serving only to accentuate the *bonâ fides* of the messenger; if the messenger is known to both parties, no stick is sent. On the other hand, there is a more or less uniformity recognisable in the shape of the sticks manufactured in different areas; the flat feather-shape of the Boulia district bears a strong contrast to the squared form of the letters met further North. Occasionally, the stick may be affixed with twine to a handle, carried vertically in front, and the suggestion has been offered that this expedient is resorted to when the messenger is travelling through hostile country, so as to give him immunity for trespassing; my experience is that, under such circumstances, he would avoid any risk of being seen by travelling only at night. I have often seen a civilised black boy, on the road, holding in front of him a short twig, in the split extremity of which an envelope, &c., has been inserted; at a distance it resembles a flag somewhat."



We reproduce one of Mr. Roth's photographs of message-sticks. There are many other forms, but these appear to be as characteristic as any.

XUM

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Specially Sensitised Plates.—A little more than a year ago I referred to the advantages of bathing plates in the prepared dye solution in order to increase their sensitiveness to green, yellow, and red, as compared with the incorporation of the sensitising substance with the emulsion before the plates are coated, and stated that Messrs. Sanger-Shepherd and Co. were preparing to issue a bathed plate commercially. The difficulty, if not the impossibility, of preparing bathed plates in large quantities that shall be uniform in the various batches and remain without appreciable change for a sufficient time to render them practically available for general work, has caused this firm to issue an emulsion sensitised plate instead. The "Sanger-Shepherd" plate is of excellent quality, moderately rapid, and shows a very even sensitiveness to red, green, and yellow, when tested by daylight. In this it is much superior to many plates specially sensitised for red or for the three colours named. The proportion of red sensitiveness to total sensitiveness in the sample I have examined is somewhere about four times as great as in the plates that Messrs. Sanger-Shepherd and Co. used to supply for use in their process of colour photography, and this indicates a very great improvement.

Plates bathed with pinachrome and with pinacyanol have recently been put on the market by Messrs. Wratten and Wainwright, and the makers state that they are of very great general sensitiveness, and that the sensitiveness of one of them at least to yellow light is almost equal to its sensitiveness to blue light. I have not seen a statement as to the sensitiveness to red of either, though they are claimed to be specially good in this matter, and presumably with very good reason.

For those who desire bathed plates without the trouble of treating them, Messrs. Penrose and Co. announce that they are prepared to sensitise plates by bathing to order, using either of the following dyes:—orthochrome T for general colour sensitiveness, pinachrome for general sensitiveness with a high speed, pinacyanol for red sensitiveness and high speed, dicyanine for sensitiveness to red extending to the less refrangible colour, and also, for green sensitiveness, tetrabromfluorescein, diiodofluorescein, homocol, and ethyl red. The plates will keep in good condition for two or three weeks. This will doubtless be a great convenience to many workers, and they will have the advantage of knowing exactly what sensitiser has been employed. On the other hand there are advantages sometimes in the use of mixed sensitisers as exemplified in commercial plates, and the experimental work that guides manufacturers is not generally available.

The Choice of Sensitisers for Red Light.—There have lately been introduced several sensitisers for red in addition to the two or three that have been known for many years. Mr. W. A. Scoble has recently communicated to the Royal Photographic Society the results of his comparative experiments with all that are practically available, nine dyes in all. For getting sensitiveness to the extreme red pinacyanol is effective as far as A, dicyanine nearly as far, while alizarine blue S sensitises into the infra red, but has the disadvantage of being, as others have found it, uncertain. In consequence of this difficulty he has selected pinacyanol as the best for his work, though his observations on the colour changes of alizarine blue S when in solution seem to go far towards eliminating the uncertainty of its effects.* A noteworthy statement in his communication is that he found no appreciable difference whether he exposed the plates wet soon after being bathed, or after being dried. The use of the undried plates saves not only the time and trouble of drying, but the risk of deterioration, which is considerable with some sensitisers.

Will Specially Coloured Sensitised Plates be much appreciated?—It cannot but occur to those who take an interest in the matter to ask themselves whether the facilities referred to in the two previous sections will meet with due appreciation. If I had to answer this question I should reply in the negative. Plates sensitised for green have been on the market for about twenty years, their advantages have been incessantly proclaimed, but even to-day they are very rarely properly used, and it is often necessary to draw attention to their existence. I should not be surprised if ten years hence red sensitised plates will still stand in need of special pleading so far as general photography is concerned. It is the needs of the trade in the practise of three-colour work that has been the chief incentive in the investigations connected with red sensitisers. The vast majority of photographers probably do not know that when they photograph a dark slated roof with a ridge of light red tiles on it, the tiles come out darker than the slates even when an "orthochromatic" plate is used with a screen. The want of discrimination on the part of photographers and those who look at their productions is the cause of the absence of a demand for correct representations, and no demand, of course, means no supply. Improvements in red sensitiveness will be quickly utilised by spectroscopists because in their work nothing can take its place; in microscopy and certain other scientific work they will slowly find appreciation; but for general purposes I fear that they will remain neglected except by an enthusiastic few. It must be admitted that it needs enthusiasm to make the sacrifices that must be made if the possibilities of such plates are to be fully taken advantage of. And certainly there is a great deal to be said in favour of the facilities that at present are incompatible with red sensitiveness.

Dark Rooms.—Photographers when working away from home, whether in the British Isles, on the Continent, or even in the more remote parts of the world, will find "A Directory of Public Dark Rooms," published by Messrs. Dawbarn and Ward at 3d., of much use. It contains nearly three thousand entries. But if anyone should happen to go on tour without such information, he should look in likely places for a bold dark blue Maltese cross six inches square on a rather larger card or enamelled iron sheet. Wherever this sign is displayed there is a dark room available, and also a copy of the directory of dark rooms that may be consulted by visitors. This arrangement is fairly well established, for it has been in force some four or five years, and in order to perfect it, the publishers would be grateful to receive any intimations of errors or omissions that are noticed in the directory.

Notice.—The Royal Photographic Society has arranged an exhibition of works by the members of the Birmingham Photographic Society, at 66, Russell Square, which will remain open to the public daily till the 16th inst.

* Since writing this Mr. Scoble has personally assured me that by observing the precautions as to colour changes given in his paper, he finds that the uncertainties hitherto found in the use of alizarine blue are entirely eliminated

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Determination of Stellar Radial Velocities with the Prismatic Camera.

MANY attempts have been made during the last few years to utilise the large light-grasping power of the objective prism for determinations of stellar radial velocities. The chief difficulty is in consequence of there being no known method of introducing a comparison spectrum to give the constants from which to measure the displacements. A method has recently been described by G. C. Comstock, in which he proposes to employ a specially constructed double prism, which is fixed with the refracting angles inverted so as to give two overlapping and crossed spectra. By measuring the distance apart of known spectrum lines in the two spectra produced of each of the stars whose velocities are required, and subsequently comparing these measures with the distance between similar lines on a standard star, a determination of the velocity in the line of sight can be obtained.—*Astrophysical Journal*, March, 1906.

Results of the American Eclipse Expedition, August 30th, 1905.

The expedition was divided into three parties, the members of which occupied stations at Daroca and Porta Coeli, in Spain, and at Guelma, in Algeria. Preparations were made for photographing the corona with long and short focus cameras, and for spectroscopic photography of the sun's chromosphere and corona. Thirty-six pictures of the corona were obtained at the three stations. Several excellent spectra were photographed with the four-inch parabolic diffraction grating, ruled with 14438 lines to the inch, and having a focal length of five feet. The flash spectrum extends from D_3 in the yellow, to λ 3300, and shows a great number of lines. With the six-inch grating, the spectrum of the green coronal ring at λ 5303 shows most interesting details, at least 15 or 20 small streamers being visible for some distance beyond the moon's limb. A special feature of this corona spectrum is the presence of a *dark streamer*, almost radial, and bordered by bright streamers on either side, which was projected from the moon's limb at latitude 55° or 60°, on the sun's east limb. This peculiar feature is also well shown on the 15-foot camera pictures of the corona.

The Fraunhofer dark crescents, as seen visually with the spectroscope, became visible about seven minutes before the second contact, while D_3 and the hydrogen lines became brightly reversed at about one-and-a-half or two minutes before. It was particularly noticed that the green magnesium lines persisted until near mid-totality.

Polariscopic observations were only made at the Guelma station, with very satisfactory results. Inside of 5′ of arc there is practically no radially polarised light, showing that the luminious matter is, in all probability, solid or liquid, as is further evidenced by the continuous spectrum of this region. Between 5′ and 10′ of arc, the amount of polarised radiation increases very rapidly, indicating that this light is chiefly reflected sunlight.—*Astrophysical Journal*, March, 1906.

Parallax of the Nebulae.

The distances of the nebulæ are at present practically unknown, as on the whole they are exceedingly difficult to measure exactly, and, in consequence, direct observations of their parallax are not very consistent. In the hope that an investigation of their proper motions might give better results, J. C. Kapteyn has recently examined the extensive series of nebulæ made by Mönnichmeyer, at Bonn. For convenience and accuracy of calculation, the whole term of the proper motion is not used, but only that component of it directed *towards the antapex*. The analytical method of reduction adopted assumes that the sum of the projections on some determined direction of the *peculiar* proper motion vanishes in the case of very numerous nebulæ; of the 208 nebulæ available for the discussion, 168 were finally selected, and the mean deduced parallax of these is $0.0046'' \pm 0.0012''$. It is important to note that this value is very nearly equal to that found for the mean parallax of stars of the tenth magnitude, and as this result is from the discussion of only thirty years' observations, it is suggested that much better determinations might possibly result from a photographic investigation, which would render possible the measurement and reduction of the places of a much greater number of nebulæ.

Variation of Absorption Bands of Crystals in Magnetic Field.

All determinations of the circumstances causing modifications of spectrum lines of substances, either as to intensity or position, become of great importance in astronomical spectroscopy when applied to the examination of stellar spectra, where many peculiar features are found which have not, as yet, been produced terrestrially. Professor Becquerel has recently given an account of several researches, in which he subjected the absorption spectrum of various crystals to very strong magnetic fields, and he finds very interesting changes thereby introduced. The crystal showing the effect most clearly was Zenotine (a phosphate of yttria, with erbium and rare earths). This is a uniaxial crystal, which exhibits very fine absorption bands, which were spectroscopically examined with a Rowland grating, a nicol prism being introduced to separate the polarised components. The wave lengths of the lines observed were determined from a comparison spectrum of iron. The effect of the field (which was used up to 31,800 C.G.S.) is much larger than the corresponding action on metallic vapour spectra, and is found to vary with the orientation of the crystal, and the direction and strength of the field.

Important instances of dissymmetry are mentioned, which appear to be independent of the direction of the magnetic field. Another remarkable feature is the variability of *sense* in which the magnetic field displaces circular vibrations, whose sense is originally the same. This appears to be a selective action, which, Professor Becquerel suggests may be due to certain bands corresponding to the vibrations of *positive electrons*, which, if proved, will add considerably to our knowledge of the inner constitution of matter.—*Comptes Rendus*, 13-15 (1906).

New Radcliffe Catalogue of Stars for Epoch 1900.

The new catalogue recently issued from the Radcliffe Observatory, Oxford, contains the results of observations made with the transit circle between the years 1894 and 1903, both inclusive, under the direction of A. A. Rambaut. Owing to various causes beyond control, the observations were interrupted several times, but this has not been allowed to influence the precision of the results, which are shown to be of a high order of accuracy. The present catalogue gives the position of every star down to the seventh magnitude contained in the zone 85°—90° N.P.D., with very few exceptions, and those only in the case of double or multiple systems.

Very elaborate determinations of the pivot errors were made by a modification of Hamy's method, in which interference fringes were produced between two plates, one of which suffered displacement when various parts of the pivot were being examined.

Full analytical details are given of the reductions, and comparisons with other standard catalogues.

Shadow Bands at Sunrise and Sunset.

Another series of interesting observations, which appear to throw light on the curious shadow band phenomena during total solar eclipses, have been recently described by Monsieur C. Rozet. In December, 1905, M. Amann saw distinct bars of light and shade on the surface of a partition, at the instant of the sun's appearance above a mountain. This led M. Rozet to make arrangements for obtaining a more definite determination, and he fitted up a

white screen inside a room facing the point of sunrise. The bands were easily seen, and were generally straight, parallel, and not at all likely to be confounded with the irregular shadows produced by convection currents near the screen. As the result of 75 observations, he makes the following conclusions :—

(*a*) The orientation of the dark bands, on a screen of perpendicular rays, is constantly parallel to the part of the mountain edge over which the sun is rising or setting.

(*b*) The direction of their displacement is always perpendicular to their orientation, but may be in one of two directions direct or retrograde.

(*c*) The velocity of the motion of the bands varies considerably from time to time, which may have some relation to the force of the wind, as the most rapid movements occur during high winds, and the slow ones during calm weather.

(*d*) The bands cease to be visible two or three seconds before the sun sets, and may become visible several seconds after sunrise. If the disappearance of the sun takes place behind a vertical screen, the time of apparition may be lengthened to 12-15 seconds.

(*e*) At first the bands are wide and far apart, becoming sharper and straighter later. Their width usually was 3-4 cm., and distance apart 3-4 cm., but might vary from 1-20 cm. The width and distance apart appeared to vary with the velocity of translation.

(*f*) The colour of the bands was generally of a uniform grey.

The distances of the mountains over which the phenomena have been observed, have varied from 6-36 km., with elevations of 3°-22°. In spite of these variations, the features of the bands have been fairly constant.—*Comptes Rendus*, 15, 1906.

Vesuvian Origin of Paris Fog, April 11th, 1906.

In corroboration of the evidence furnished by the many striking sunsets during the latter part of April, there may be considered the finding of volcanic dust in Paris just after the eruption. M. S. Meunier describes how, during the dry, yellow fog which enveloped Paris on the 11th of April last, he exposed gelatinised plates near the Quay Voltaire, and after treating these with water, he obtained a deposit from which the soot and organic matter were removed by Thoulet's heavy liquid. There remained an extremely fine residue, the microscopic examination of which showed almost perfect identity with a sample of the dust emitted from Vesuvius in 1822. The chief difference consisted in the presence with the Paris dust, of small, perfectly spherical globules of oxide of iron. It thus appears most probable that the Paris fog was produced by a fine rain of cinders which had been carried from the Vesuvian area.

Photography of Corona without Eclipses.

MM. Millochau and Stephanik propose to start a new attack on the problem of photographing the solar corona during daylight, by combining the use of the spectroheliograph and coloured screens. As the corona is projected on a background of extremely bright sky, it is hoped that the relative intensity of the corona will be enhanced if a screen is interposed which cuts off all light except that of a green colour in the region of wavelength 5303. Then, by setting the secondary slit of their spectroheliograph on this line, the increased contrast produced may render possible the record of the coronal form. Preliminary attempts at Meudon are said to have given encouraging results, and the apparatus is to be transferred to the Observatory on the summit of Mont Blanc, where the absence of the lower and denser layers of the earth's atmosphere may further conduce to success.

BOTANICAL.

By G. MASSEE.

Sexuality in the Mucorineae

IT has long been known that a sexual mode of reproduction existed in the group of fungi known as the Mucorineæ, of which the moulds common on bread and various fatty matters are well-known examples. The result of sexual fertilisation consists of a structure called zygospore, which, after a period of rest, germinates, and at once gives origin to a mucor-plant. A second form of reproduction produced asexually is much more general than the sexual condition, and appears under the form of myriads of miniature pins, with golden heads, which eventually become black.

The subject of sexuality has recently been prosecuted from a new standpoint, by Blakeslee. It was observed that some species could be readily induced to form zygospores, by sowing spores obtained from a single fruit of the asexual form. On the other hand, in many species, zygospores were never produced from spores contained in a single asexual fruit, but only when a mass of spores from a zygosporic culture was used. When isolated cultures of the last-named group were grown in proximity on a suitable medium, it was observed that zygospores were formed along the line where the mycelium of the two colonies met. This suggested the idea that such species consisted of strains, or races, which, when grown apart, produced only a sexual fruit or sporangia, but which produce sexual fruit, or zygospores, when the two physiologically different strains are grown in contact. These are designated respectively + and (−) strains, which is considered as non-committal as to the sexual relation of the respective strains.

This condition of things is essentially similar to that present in dioecious plants and animals, although morphological differentiation is not obvious in the Mucorineæ.

The term heterothallic is used to designate those forms that are dioecious, and homothallic is applied to the hermaphrodite species. Hybrids have been produced from (+) and (−) strains of different species of the heterothallic type.

The following is a part of the author's summary of this important discovery :—

"The production of zygospores in the Mucorineæ is conditioned primarily by the inherent nature of the individual species, and only secondarily by external factors.

"According to their method of zygospore formation, the Mucorineæ may be divided into two main groups, which have been termed respectively homothallic and heterothallic.

"In the homothallic group, comprising the minority of species, zygospores are developed from branches of the same thallus or mycelium, and can be obtained from the sowing of a single spore.

"In the heterothallic group, comprising probably a large majority of the species, zygospores are developed from branches which necessarily belong to thalli or mycelia, diverse in character, and can never be obtained from the sowing of a single spore. Every heterothallic species is, therefore, an aggregate of two distinct strains, through the interaction of which zygospore production is brought about.

"These sexual strains in an individual species show in general a more or less differentiation in vegetative luxuriance, and the more or less luxuriant may be appropriately designated by the use of (+) and (−) signs respectively.

"A process of imperfect hybridisation will occur between unlike strains of different heterothallic species in the same, or even in different genera.

"From the foregoing, it may be concluded that the formation of zygospores is a sexual process; that the mycelium of homothallic species is bisexual; while the mycelium of heterothallic species is unisexual; and finally, that the (+) and (−) strains of the heterothallic group represent the two sexes."

The zygospores require a period of rest before they are capable of germination.

Marine Fungi.

H. E. Petersen has studied the microscopic fungi belonging to the Chytridineæ, parasitic on marine algae. Twenty-five species were collected on the Danish coast, and further north, and are described in detail in *Overs. k. Danske. Vivensk. Selsk., Folk.*

New British Algae.

Notwithstanding the work of centuries in investigating the flora of Britain, additional new, or previously unrecorded, species continue to be found. Batters, in *Journal*

of Botany, has some interesting notes on eleven new or critical species of British marine algae. Two of these were previously unknown, and three more belong to genera not previously recorded as British. Most of the species are minute, of the two new species, one, *Diplocolon Codii*, grows between the cortical cells of another alga, *Codium tomentosum*. The other new species is named *Mesogloia neglecta*, which has probably been previously passed over as *Mesogloia Griffithsiana*, which it superficially much resembles, but is distinguished by the much shorter cortical filaments and larger spores.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Action of Radium on Precious Stones.

EXPERIMENTS made by Herr Miethe have shown that many precious stones are changed in colour when exposed for some time to the action of radium rays. Thus a colourless diamond from Borneo became pale yellow after eight days' exposure to the rays of an impure radium bromide, and the colour became much darker after another eight days. Heating the stone to redness reduced but did not destroy the yellow coloration. In the case of a sapphire, the light blue colour changed to green after two hours' exposure to the rays, then yellow, reddish yellow, and, finally, after 14 days, yellowish-brown. The colour disappeared on heating the sapphire, but a light yellow tint invariably re-appeared when the stone became cold. The rays did not affect the colour of the amethyst, ruby, blue topaz, or chrysoberyl; but a tourmaline with a green end became green at any other part on which the rays were allowed to act.

Philippine Wood Oils.

Fluid resins closely resembling balsams in composition and characteristics are in common use as varnishes throughout the Philippine Islands, and the best known of these have recently been examined by Mr. A. M. Clover. *Oil of supa* is obtained from *Sindora Wallichii*, a tree widely distributed throughout the Islands. The oil, of which about ten litres are collected from each tree, is a mobile pale yellow liquid, which rapidly becomes dark and viscous on contact with the air, and slowly dries to a hard film when spread in a thin layer. In certain districts it is also used as a lamp oil. A similar product known as balao, or *oil of apitong*, is collected by cutting cup-shaped cavities in the apitong tree. It is white when fresh, but rapidly darkens on exposure to the air, and spread in thin films forms a very tough varnish. It is superior to supa oil in its drying properties, and also differs from it in becoming solid on contact with steam. Malapaho, or *oil of panao* is a colourless product, obtained from the tree *Dipterocarpus verniciffuus* by the same method. It dries but slowly on exposure to the air, and is thus not used to the same extent as balao or supa oil. It also differs from the former in becoming more mobile under the influence of steam. Chemically, all these wood oils consist almost entirely of the hydrocarbons known as sesquiterpenes. They are more or less volatile in a current of steam, and are quite distinct from the ordinary drying vegetable fixed oils, such as linseed or walnut oils, which consist of compounds of glycerin with different fatty acids.

Trachinus Venom.

It had long been suspected that the poison glands of the greater weever (*Trachinus draco*) contained a definite toxine, but it was not until 1903 that this was shown by M. Briot to be the case. He obtained poisonous solutions possessing the characteristic properties of true toxines by extracting the gland with glycerin containing chloroform, but did not isolate the poison in anything approaching a state of purity. The work that has been done on the subject is reviewed by Dr. Oppenheimer in "Toxine und Antitoxine," an English edition of which is now announced. The toxine has a direct action upon the heart and causes convulsions and paralysis, the latter being a characteristic symptom. It is destroyed by being heated for 30 minutes at 212° F. and by calcium chloride and gold chloride. In addition to its toxic function trachinus venom resembles snake venom in having a hæmolytic function, *i.e.*, the power of dissolving the red corpuscles of the blood. This lysine in the venom is destroyed when heated for about 20 minutes at 212° F., and is thus less stable than the toxic principal. The normal serum of the horse contains an anti-hæmolysine against trachinus lysine, just as it does against the hæmolysine of snake venoms. Trachinus venom, however, is quite distinct from snake venom, for it acts in quite a different manner, and a serum rendered antitoxic to snake venom has no effect upon either the toxic or hæmolytic function of trachinus venom. It is possible to produce a certain degree of immunity to the venom in rabbits by cautious injection of a diluted venom, and the serum of the treated animal then contains a specific antitoxine, which, however, does not invariably afford protection against the local effects of the poison. The venom of *Trachinus vipera* is very similar to that of *T. draco*, as regards its effect upon guinea pigs, but has much less action upon rabbits. Several other fish, *e.g.*, the lamprey, appear to contain poisons which act as definite toxines, but these have not yet been investigated. The venom of the poisonous Japanese *Tetrodon* (*fugu*) and of certain other fish, appear to contain poisonous compounds of the nature of substituted ammonias rather than true toxines, *i.e.*, unstable specific poisons capable of producing specific antitoxines in the serum of an animal.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Great Californian Earthquake.

THE stoppage of the fires of Vesuvius has been signalised by a great earthquake which has laid San Francisco in ruins, and has resulted in a devastation such as has been unknown in any civilised territory during the present generation of mankind. Was there any connection between the one and the other, is a question which will at once be asked. The greatest caution must be exercised before giving an answer. If merely a coincidence, it is a remarkable one. It is certain that an enormous vacuity must have been formed in the place which fed the eruption from Vesuvius. Other material must have flowed in from regions around, and stupendous underground movements of the kind would have equivalent results. The result might be a caving-in, through lack of support, of some spot of weakness in the earth's crust, and the formation of one or more great faults. The shock or shocks which would be given rise to would travel in every direction, and when they reached the surface of the earth the effect would be disastrous. Possibly secondary shocks would follow later from refraction or reflection from the earth's central core. To some such causes the present earthquake is attributable, and in this connection it is well to remember that the great Charlestown earthquake followed the closing of the great crator of Kilauea, in the Sandwich Islands.

Some Details of the Recent Eruption.

While the recent Vesuvian outburst was fresh in the public mind, Professor Guiseppe de Lorenzo contributed a paper to the proceedings of the Geological Society, which he wrote while yet the decrescent phase of the eruption was being pursued. The maximum outburst took place during the night of April 7-8, and blew 3,000 feet into the air, scoriæ and lapilli of lava, with fragments derived from the wreckage of the cone. A south-westerly wind swept the ash, it appears, across the Adriatic, into Montenegro, whilst the lava flowed south and south-west through an enormous fissure in the old rim of the crater. On April the 9th and 10th, the wind had changed to the north-east, and when the collapse of the cone of the principal crater occurred, it was accompanied, or rapidly followed, by the ejection of steam and dust to a height of 22,000 to 26,000 feet. This changed the direction in which the dust was carried, and it now reached the shores of Spain; but on the 11th the cloud was impelled northward. On the 13th the giant cone was found to have a horizontal rim very little higher than Monte Somma, and with a crater about 1,000 feet in diameter, the cone being almost snow-white from the deposit of sublimates. Asphyxiation caused many deaths,

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and it was particularly noticed that when the lava-streams surrounded trees many of those which stood upright amongst the hot lava retained their leaves and blossoms apparently uninjured.

Changes in the Sea Level.

As showing possibly some submarine action in the way of subsidence of the bed of the sea, it was noticed that the sea-level was lowered, on the 7th and 8th of April, six inches, near Puzzuoli, and as much as twelve inches near Portici, and it had not returned to its previous level on April 18. More information on this head is certainly desirable. The alteration of a sea-level in a small tract, not observed beyond that tract, cannot remain permanently, and it remains to be seen whether the sea will resume its position. Otherwise, should it not prove to be the trough of a huge wave-undulation, which would afterwards change to a devastating wave thrown upon the land, the cause must be looked for in an elevation of the coast-line in question. It will have been noticed that Puzzuoli is one of the places to which reference is made, and the instance of the subsidence and subsequent re-elevation of the columns of the temple, said to have been dedicated to Jupiter Serapis, will at once come to mind, as having occurred at the same place.

Those who remembered the fine sunsets which occurred after the eruption at Krakatoa, in 1883, were on the watch for similar phenomena in April. Nor were they altogether disappointed. Some very fine sunsets were seen, but collected information on this head is required. Our readers will perhaps bear in mind that we shall be glad to receive records of such sunsets, with time, date, and place where observed.

Foreign Boulders in the Chalk.

Mr. G. E. Dibley, F.G.S., has been fortunate in discovering a fine mass of quartzite, weighing three pounds, in the chalk of Strood. The question of the method by which this and similar erratics were carried and dropped in the chalk-sea is a fascinating one. Various means have been suggested. Conveyance by means of ice is a likely explanation, whilst it has also been suggested that they may have been carried out to sea, entangled in the earth at the roots of storm-tossed trees wrenched from the soil of a neighbouring coast. Mr. Dibley's exploration of the chalk at Burham, near Rochester, has also resulted in the discovery of a fine set of teeth of *Ptychodus decurrens, Ag.* (*var. depressus*), from the zone of *Holaster sub-globosus*.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Ducks assuming Drakes' Plumage.

DR. C. G. SELIGMANN, the Pathologist to the Zoological Society, contributes an extremely interesting article to the columns of the *Field*, May 12, on the subject of the assumption of the male plumage by female ducks.

His observations were made on two domesticated birds, and extended over a considerable period. In both cases these birds for several years laid eggs and reared broods, but suddenly became sterile and gradually assumed the plumage of the drake, even to assuming the characteristic "eclipse" plumage. One of these birds, it is significant to note, did not enter on this abnormal phase until ten years of age, and the other at five years of age.

Both birds, on assuming the drakes' livery, refused all intercourse with males, but what is more curious, they assumed the conduct of males towards the females with which they were penned.

'As it has been found inconvenient," remarks Dr. Seligmann, "to have no single word to describe a bird which has assumed the plumage of the opposite sex, whether of the female or the male, or *vice versâ*. . . . I have ventured to term such birds alopterotic (ἄλλος, other: πτερωτος, feathered)."

Bittern in Devon.

Mr. C. H. Calmady-Hamlyn in the *Field* (April 14) tells how he unintentionally shot a Bittern (*Botaurus stellaris*) at Bridestowe, Devon, on January 11. He fired through a clump of thorns at what he believed to be a wild duck, but found on recovering his victim a Bittern. Fortunately the bird was only very slightly wounded in the wing. He therefore took it home and kept it a few days in his garden, where it quickly recovered and ultimately took its departure. The bird has since been seen several times by a friend of Mr. Hamlyn's, and it is hoped was not eventually killed.

Hoopoe in Kent.

The appearance of a Hoopoe on a garden lawn in Kent is certainly worthy of record. Mr. A. Randall Davis, who had the good fortune to be thus favoured on April 6, accordingly sent a short account thereof to the *Field* (April 14). The bird stayed until the 8th and then vanished; but during its stay appeared very tame, though mobbed at first by thrushes, blackbirds, and jackdaws. After an hour or two, however, "all had settled down quietly together." With a little encouragement, as we have before remarked, it is possible that this bird might be induced to live here regularly.

The issue of the *Field* for the following week (April 21) brought a note from Mr. Charles Ticehurst, who saw a Hoopoe on the Golf Links at Rye on April 7. Thus, if these birds escaped the gunners, it is possible that chance may have brought them together, since Hythe is not far distant, and in that case, assuming them to have been a pair, we may yet hear of another instance of the Hoopoe nesting in England.

Lapwings Swimming.

Though not generally known, it is a fact that the Lapwing (*Vanellus cristatus*) frequently takes to the water. On one occasion indeed a flock were observed resting on Lough Derg, co. Limerick, two miles from land, the wind blowing hard from the east. Apropos of this, Mr. H. W. Robinson contributes a note to the *Field* (April 21) to the effect that he has seen "young lapwings not long hatched swimming about in ditches like ducklings, and [has] also seen them land afterwards and run up to their parent." This fact is probably new to most of our readers.

Nesting of the Egyptian Plover.

The remarkable nesting habits of the Egyptian Plover (*Pluvianus ægyptius*) are by no means yet thoroughly understood. This bird has a habit of burying its eggs in the sand, but whether covered for the purpose of concealment, as the Grebes cover their eggs when leaving them, or whether they are left to be incubated by the heat of the sun, is not yet certain. Nor is it known whether birds which have been seen sitting on these eggs have first uncovered them, or whether, as has been suggested, they are merely protecting them from the intense heat of the sun. In the current number of the *Avicultural Magazine*, Mr. W. G. Percival contributes further testimony as to the burying of the eggs, but does not offer any suggestions on the above points.

Arrival of Summer Birds.

Going to Press early last month on account of the Easter holidays, we were unable to bring our list quite up to date, and herewith add a few further notes:—

Swallow—Seaton, Devon, April 3; Newhaven, Sussex, April 5.
Nightingale—Caterham, Surrey, April 7.
Black Cap—Stroud, Gloucestershire, April 6.
Whitethroat—Lancaster, April 8.
Sedge Warbler—Market Harborough, April 13.
Cuckoo—Surrender Park, Kent, April 11.
Wryneck—Guestling, Sussex, April 5; Cranbrook, Kent, April 6.
Nightjar—North Finchley, April 28. This abnormally early record is commented upon by Mr. W. B. Tegetmeier in the *Field*, May 12.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Absorption of Alpha Streams.

THE work on the products of Radium is now necessarily one of detail, in which gaps are being filled up or laws supple-

mented. Professor Bragg last year showed that the "stopping-power" of an atom of any gas for the Alpha streams was a constant of the atom, unaffected by its association with other atoms in molecular structure, and independent of temperature and pressure. The second of these statements implies that if we know the stopping-power of the constituents of a compound gas we find the value for the gas itself by simple addition. Not only so, but the stopping-powers are very nearly proportional to the square roots of their atomic masses, so that a simple, if approximate, law covers all the phenomena. Professor Bragg has since extended these observations; and shows, moreover, that not only are the stopping-powers systematic, but show also a systematic deviation from the square-root law. For whilst depending mainly on the square roots of the atomic masses, they have a leaning towards the masses themselves.

This is shown by the following numbers selected from a much larger table in the *Philosophical Magazine* for May.

	Experimental Value.	Proportional to √Atomic Mass.	·118 √m + ·003 m
Hydrogen . . .	·243	·264	·242
Carbon dioxide .	1·47	1·51	1·48
CH_3I	2·58	2·35	2·52

In each of these columns the value for air must be taken as unity. The table shows clearly that closer correspondence with experiment is brought about by introducing the additional term.

The same law holds for substances in the solid state; thus the stopping-power is independent of the mode of aggregation. Now the Alpha particle expends energy in causing the expulsion of electrons from the atoms of any gas which it traverses. Since the expenditure follows the same law when the particles are massed together into a solid, it would seem that the solid must also become ionised, just as the gas is, and we should expect slow-moving electrons to be projected from Radium itself and from both sides of any solid screen through which the particles pass. These may be the slow electrons discovered by J. J. Thomson. This at least is Bragg's conclusion, and it is in conformity with Soddy's opinion. It must, however, be also borne constantly in mind that the slow-moving electrons supply the deficit which would otherwise appear of negative electricity. The emanation throws off a positive charge, and yet becomes itself positively charged (for it moves toward the *negative* terminal). Where is the corresponding negative charge if not in the more recently discovered slowly-moving electrons?

Standard Wave-lengths of Light.

It is now generally recognised that the efficiency of a diffraction-grating in the measurement of wave-lengths has been very much over-rated. Different first-class gratings give different values. A warning thrown out by Lord Rayleigh as early as 1888 against exaggerated expectations; there is now no doubt that the warning was justifiable. Attention has been directed in the last few years to methods based on the interference between the different beams which emerge after multiple reflections through a layer of air bounded by the two plain parallel surfaces of slabs of half-silvered glass. Methods such as this are usually distinguished as *interference* methods (such an arrangement is called an *interferometer*); but Lord Rayleigh is very emphatic in saying that such methods have no more claim to the title than the diffraction grating itself. In each method final effect is obtained by focussing to a point on a screen (or focal plan of an eye-piece) a succession of beams whose phases are different owing to the different paths travelled. The essential feature which distinguishes the parallel plate method is the greater simplicity which allows greater accuracy in construction.

Lord Rayleigh has modified the original arrangement of Fabry and Perot in the direction of simplification without apparently any loss of accuracy; and he has measured several of the leading standard reference lines in various spectra. It is noteworthy that in all cases Fabry and Perot's values are verified *to within one part in a million* and in some cases to considerably less. This is a most important result, since although it was well recognised that their values had been made with the greatest care and precision, yet they stood on their own merits. The present confirmation, by a modified method, proves that they deserved all the reliance which physicists were disposed to rest upon them.

Directed Wireless Telegraphy.

IN the ordinary systems of wireless telegraphy there is no means of knowing the direction from which the signals have arrived, or to send signal in one direction only. Theoretically it would be possible by means of a sufficiently large parabolic mirror to concentrate all the radiation along a single path; but the size of the mirror necessary for this would be heroic. This arises from the fact that very long waves are employed; for such waves the mirror must be proportionately large. It has now been found out by Signor Marconi and those working with him that when the "aerial" is placed horizontally instead of vertically, and with the spark at the end away from the sending station, a similar receiver picks up far more energy when the two are in one straight line. In this arrangement it is clear that it must be the magnetic component of the wave which is most efficient in producing the signal. This discovery would seem to mark a distinct advance in this important practical subject.

ZOOLOGICAL.

By R. LYDEKKER.

Habits of the Dugong.

SOME interesting notes on the habits of the Indian dugong, or sea-cow, are published by N. Annandale, of the Indian Museum, Calcutta, in the *Journal of the Asiatic Society of Bengal*, for last year. After stating that dugong feed largely on a green alga, as well as on a marine phanerogamous plant, the author proceeds to observe that the method of feeding does not appear to be the same as in manatis, which pluck the plants they eat by means of the two lobes above the upper jaw-pad, and push their food towards the mouth with the flippers. Similar lobes certainly exist in the dugong, but they do not appear in fresh specimens to be capable of any great degree of separation or movement, while the flippers are hardly long enough to give any assistance in feeding. As the upper jaw-pad (upper lip) itself, on the other hand, is evidently freely movable, and possibly to some extent extensile, it seems possible that it is used in plucking sea-weed, which certainly could be grasped between it and the lower jaw.

The author adds that, according to the fishermen, a single young one may be seen with a female at any time of the year; but on no occasion had they observed a female nursing its offspring with one of her flippers, while her head and fore-part of her body were raised out of the water after the fashion supposed to have given origin to the mermaid myth.

Colour Evolution in Monkeys.

A paper in the current issue of the Zoological Society's *Proceedings* is devoted to the evolution of a remarkable type of colouring in the tropical African monkeys commonly known as guerezas, from the native name of an Abyssinian species. Starting from a wholly black species, a gradual transition can be traced to one in which the sides of the face, flanks, and hind-quarters, together with nearly the whole of the tail, are furnished with long fringes of pure white hairs, apparently developed to accord with the pendent white lichens clothing the branches of the boughs among which these monkeys dwell.

Ox-Warbles.

According to Mr. A. D. Turner, it is still unknown how the maggots which form the tumours known as "warbles" on the backs of cattle effect an entrance into the bodies of their hosts—whether by boring through the skin, or by being swallowed by the animals while in the egg-state, and subsequently eating their way through the walls of the gullet, and thus eventually reaching their final places of development. The point is an important one to cattle-owners, as "warbles" are a source of very serious loss alike to the butcher and to the dealer in hides and leather.

XUM

Aquatic Mice.

If we except the water-rat, the small mammals that have taken to an aquatic life in Europe and Asia are chiefly shrews, of which several distinct generic types are known, among them our own water-shrew. In South America, on the other hand, according to the researches of Mr. O. Thomas, of the British Museum, it is mice that have adapted themselves to this mode of life. Some years ago that gentleman described one of these water-mice, which feeds on small fishes, under the appropriate name of *Ichthyomys*; its home being the mountain-streams of Peru. Recently, he described a second, distinguished by the absence of ears, under the equally apposite title of *Anotomys*. Now, he has had the good fortune to be able to name a third as *Rheomys*, nearly allied to the second, but distinguished by the retention of ears and its glossy fur. From both the others, the first-named genus differ by the peculiar structure of its incisor teeth.

Papers Read.

At the meeting of the Zoological Society, on April 10 (the only one held during the month), Mr. C. T. Regan communicated a paper on Trinidad fishes; Messrs. Thomson and Henderson described alcyonarian zoophytes from Zanzibar; Dr. J. F. Gemmill discussed the phenomenon of "cyclopia" in trout-embryos and other fishes; while Mr. P. I. Lathy described certain butterflies.

REVIEWS OF BOOKS.

BOTANY.

Alien Flora of Britain, by S. T. Dunn, B.A. (West, Newman, and Co.; 5s. net.)—Most British botanists will probably be somewhat astonished to learn that the author considers 924 species, or practically half the number of British plants, as aliens, or in other words plants that have been introduced either directly or indirectly through human agency. The crucial test adopted is as follows: If a plant is found growing in perfectly wild and natural surroundings it is deemed indigenous, whereas if a plant only occurs in cultivated areas it is considered as an alien. This test dubs as indigenous all plants growing in elevated regions, or in localities that have for some reason not been disturbed by man, whereas broadly speaking, plants that grow in cultivated land, hedge-rows, &c., are introduced, or aliens. Now as the great bulk of land, say, below 500 feet elevation, has within the last thousand years been under cultivation at some time or other, and much of it almost continually so, it is difficult to conceive lowland plants as occupying other than cultivated areas if they succeeded in surviving at all. Many widely distributed plants now thoroughly naturalized, are undoubtedly aliens, having been introduced accidentally along with grain, wool, ballast, &c., and some of these have been with us for centuries; but before such a wholesale statement as to numbers can be accepted, stronger and more convincing evidence than is contained in the work under consideration will be required. Apart from the leading question, the book contains much useful information respecting the habitats and geographical range of the plants dealt with.

CHEMISTRY.

Treatise on the Effects of Borax and Boric Acid on the Human System, by Dr. Oscar Liebreich (translated from the German. London: J. and A. Churchill; pp. vii. + 70. 5s. net).—An interesting series of experiments on living subjects was recently concluded by Dr. Wiley, of the U.S. Department of Agriculture, who arrived at the conclusion that borax and boric acid were undoubtedly injurious when used as preservatives in food. In this pamphlet, which is well illustrated with diagrams, Dr. Liebreich subjects Dr. Wiley's results to a critical examination, and comes to the opposite conclusion. He considers that any injurious symptoms observed were due to unsuitable hygienic conditions and to the choice of unsuitable persons for the experiments, and not to the effect of the borax. The pamphlet will be read with interest by those who are interested in the subject, but it shows the necessity of much more work being done before a definite conclusion can be formed. It may be mentioned that the Parliamentary Committee on Preservatives, in this country, came to the same conclusion of "not proven," as Dr. Liebreich, notwithstanding some strong medical evidence in the other direction, and recommended that a small proportion of boric acid should be permitted in butter, cream, and hams. The question, however, is still unsettled, and no tradesman who ventures to use boric acid can consider himself safe from prosecution. In fact, so chaotic is the law that quite recently a shopkeeper, summoned for selling preserved food in one borough, called the Medical Officer of Health from an adjoining county as a witness for the defence, and won his case. This pamphlet of Dr. Liebreich is also likely to appear frequently as a witness for the defence in similar cases, which will continue until such time as we have the matter properly thrashed out and the use of preservatives either legalised or made illegal.

ETHNOLOGY.

Mexican and Central American Antiquities, Calendar Systems, and History. Twenty-four papers. By E. Seler, E. Förstemann, P. Schellhas, C. Sapper, and E. P. Dieseldorff, Smithsonian Institution, Bureau of American Ethnology. Bulletin 28, Washington, 1904. The late Director of the Bureau of American Ethnology was very well advised when he determined to publish translations of a number of foreign papers on the archæology and glyphic writing of the semi-civilised peoples of middle America. These have now been published under the supervision of Charles P. Bowditch, and they afford to the ethnologist a mine of information on subjects to which otherwise he could obtain access only with the greatest difficulty. One has only to glance at this well illustrated book to see that it is of interest not merely to the Americanist or archæologist, but also to the general ethnologist. The latter, however, will have to search for his material, as most of it is scattered all over the volume, and pick out what he requires from papers of diverse kinds, but in some cases, as in the articles on the priesthood, ceremonials, deities, and religious conceptions of the Zapotees, he will find it pretty fair sailing. In a new subject, such as this, and dealing with interpretations based on glyphs which have no "Rosetta Stone" to guide them, authorities are apt to differ from each other, and to modify their own previously expressed opinions, thus the reader must be continually on the watch for these pitfalls. Mathematicians and those who like number puzzles will find full scope for their ingenuity in the consideration of the Maya Calendar. According to a widespread tradition, the Toltec nation was the originator of all arts and sciences, and among other things the invention of the calendar is ascribed to them, and we are told that they carried their books with them on their migrations. The calendar is the alpha and omega of the Central American sacerdotal wisdom, and the great mass of Mexican and Maya manuscripts is nothing more than an elaboration of this calendric system in respect of its numerical theory, its chronology, and its system of divination. The nature of this calendar, consisting in the fact that it originated from the fundamental number 20 in combination with the number 13, is well known. A simple calculation shows us that the peculiar period of 52 years in use among the Mexican races proceeds directly from the application of this fundamental system to a solar year of 365 days. There is still a diversity of opinion as to how far the Mexicans themselves were able to harmonise this system with actual time, the solar year, and the revolution of the various heavenly bodies. Among the Maya races the system seems to have been brought to perfection on the numeric-theoretic side in particular. It seems certain that not only the movement of the sun, but also the movements of the large planets were noted, and that these people were capable of connecting the period of revolution of these bodies with the solar year of 365 days, and with the period of 20 × 13 days, the true basis of the system. The apparent period of revolution of Venus may be set down with tolerable accuracy as 584 days. Five such revolutions give us the figures of 2,920, or eight solar years of 365 days. This precise number is plainly the basis of the computations on certain pages of the Dresden manuscript. But 65 such periods give us the number of 37,960,

that is, double the period of 52 years, which is the direct result of the application of the designation of days in accordance with the system of the 20 characters and the 13 digits to the solar year of 365 days. In like manner the revolution of Mercury around the sun, which is completed in 115 days, seems to be brought into connection with the period of 20 by 13 days; for 104 of these revolutions produce the number 11,960, which is also forty-six times the period of 20 by 13 days; and this number clearly forms the basis of other pages in the Dresden manuscript. Unfortunately, it is almost hopeless to look for an exact chronology in the native manuscripts or monuments, but several acute scholars are working hard at these difficult glyphs, and the publication of this book will enable others to follow their labours with greater ease.

Haida Texts and Myths, Skidegate Dialect. Recorded by John R. Swanton. Ibid. Bulletin 29, Washington, 1905. A very considerable number of folk-tales have already been collected in North America, but Prof. W. H. Holmes, the chief of the Bureau of American Ethnology, in succession to the late Major Powell, rightly considers that the whole of it should be collected and published, as they form a very important element in the ethnological study of a people, especially when, as in this case, the tales are given as literally as possible. Many of the tales are printed also in the vernacular, and thus they have a philological value in addition to the insight they give into the religious ideas of the people. One is impressed by these tales by the tremendous hold spiritual power has over the imagination of these as of most other North American peoples, for success in life is attributed to it in the same manner that the Melanesians regard all good fortune as the result of Mana, a term which an American would translate as "medicine." Incidentally these tales throw light upon the social and daily life of the natives.

GEOLOGY.

The Founders of Geology, by Sir Archibald Geikie, F.R.S. (Macmillan and Co., pp. 486, 10s. net).—We are glad to see this work in a second edition, covering as it does ground which to many is as a sealed book. Geology becomes the more interesting when one studies the work of pioneers of the science, and the obstacles which they had to overcome. Opportunity has been taken to considerably extend the scope of the edition of 1897, and to give a sketch of the progress of geological ideas from the times of Ancient Greece onwards. Naturally, the greater part of the book is taken up with the lives of leaders of the 19th century, in the halcyon days of the science, whilst in the period approximating to the present day the men famous in geological discovery are so numerous that the narrative has of necessity to be confined to the mention of but a few. Perhaps contemporary geologists will form the subject of another volume, and among the first to be mentioned in such a connection will be that of the author.

E. A. M.

METEOROLOGY.

Meteorology in Mysore for 1904, being the results of observations at Bangalore, Mysore, Hassan, and Chitaldrug. Twelfth Annual Report.—This publication, by John Cook, M.A., F.R.S.E., &c., director of meteorology in Mysore, is worthy of the "Model State," containing as it does in addition to the ordinary features associated with an annual meteorological volume, a complete and comparative summary for the whole 12 years of the establishment, which is also a model in itself, the four stations, at the corners of a not quite regular quadrilateral, having been founded successively in a little more than a year (Bangalore observations commencing April 1, 1892, and Mysore, May 10, 1893), and being provided with similar staffs and equipment, so that the work is readily comparable. For Government purposes the formula adopted to give daily mean temperature is apparently considered insufficient, a second formula called the Government of India mean being also employed for official purposes. India, however, is too large a district for an empirical formula to be of universal application, and it is obviously not quite right for Mysore. It would seem better to determine the daily variation for every district separately, if not for every observatory, as is done for some British stations, for instance, and use that instead of the Government formula. Some interesting features from our insular point of view may be noted in connection with the actual results. The extreme range of the barometer for the year is only about half-an-inch, but as all the stations are high (2,400 ft. to 3,100 ft.), and tropical, this is more a matter for satisfaction than surprise. The maximum temperature for the year was 94°.0 at Hassan, 97°.3 at Bangalore, 99°.9 at Mysore, and 100°.3 at Chitaldrug, all on different dates. The minimum readings being respectively 46°.5, 51°.9, 53°.2, and 55°.3, also on different dates, and only two in the same month. It is fairly dry, the humidity at each station running down to nearly 10. The actual figures are 9, 10, 12, 13. There is not much wind, the greatest daily movement being 462 miles at Mysore, that at Hassan never exceeding 175 miles; the total rainfall at the wettest station, Bangalore, being 31¼ inches, and at the driest, Chitaldrug, 23 inches; Hassan, however, heading the list of wet days with 111 and of daily fall with 3¾ inches. There are instructive plates giving curves of daily mean barometer, dry bulb, wet bulb, maximum and minimum temperature, rainfall cloud, wind velocity, and direction for each of the four stations, and also six-day and monthly mean curves for several elements compared with those for Madras. We may congratulate the model state on having secured a model director, and the director on the opportunity of continuing a work which will grow in value with every year, in a climate which for many reasons seems eminently fitted for meteorological investigations.

SCHOLASTIC.

Elementary Electrical Calculations. W. H. N. James and D. L. Sands (Longmans and Co., 3s. 6d. net).—This consists in details of calculations such as an electrical engineer requires to make. It is the outcome of a number of lectures on such calculations and is intended as supplementary to much class work. The calculations are of an elementary nature, and for this reason there are none in connection with alternating currents, self-inductance, and capacity, the properties of which can be adequately studied only by a senior student. We think, however, that in this elementary book it would have been very advantageous to deal with some electrostatic problems without which a student will never thoroughly understand the part played by condensers in alternating work.

The treatment here is accurate; but it must be understood that the theory underlying the calculations is not given; for this the reader must have recourse to other text-books or to class teaching. The solution in many cases is obtained by means of curves; these certainly prove of great aid in enabling one to understand the variation of any quantity.

First Stage Physiography (Section I.), by R. Wallace Stewart, D.Sc. "The Organised Science Series." (University Tutorial Press, Ltd., pp. 256, 2s.)—This section deals with mechanics, physics, and chemistry, with experiments, questions, and answers to each part. It is a useful and reliable little handbook, and we are able to give the same commendation to this as to others of the same series which have been mentioned in these columns. It is fully illustrated with diagrams of a useful and appropriate nature. E. A. M.

A NEW catalogue of educational books has just been issued by W. A. Foyle, 135, Charing Cross Road, henceforward to be known as W. and G. Foyle. Considerable extensions of the firm's business are in progress, and separate catalogues are to be issued for civil service, university, banking, law, medical, and theological books.

Taylor's Card Calculator.—An ingenious card calculator has been devised by Mr. J. W. Taylor, of Leicester, for the purpose of the mechanical addition or subtraction of all the fractions of an inch which are multiples of the negative powers of 2, from $\frac{63}{64}$ to $\frac{1}{64}$. The device, which is manipulated by the movement of a quadrant on a semi-circle, is very easy to understand, and appears to be likely to be extremely useful in the drawing office. Decimal equivalents of all the fractions are added, together with much useful information for engineering draughtsmen.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 440.)

The plate used in photo-micrography should be, therefore, an orthochromatic one, it should be of medium rapidity in order to get contrast and latitude of exposure, and it should be "backed" to save reflections. There are many such plates on the market, the Edwards, Barnet, and Ilford plates are all well known; the first is, perhaps, the most popular, but according to some very interesting tests made by Dr. Spitta, the "Isochrom" plate of the Ilford Company has a wider range, and is, therefore, superior. The Lumière plate is rather more expensive, and the Cadett plate has the largest range of all, but is awkward to develop on account of this very sensitiveness. It is well to make a practice of using one kind of plate and to adhere to it except for some special reason.

The necessary screens will be two yellow screens, one of them dense, two blue screens of the same description, and a signal-green or pot-green screen. Gifford's F line screen is a very useful one, whether made of glass and gelatine or of signal-green glass and malachite green and glycerine, which passes more light.

The question of exposure is a difficult point to give hints upon, as it varies enormously with the light, the plate, and the objective and magnification, and I am afraid nothing but trial and experience will be of service. Two things may be said, however; firstly, that orthochromatic plates of medium speed have extraordinary and unexpected latitude in this respect, and, secondly, that in case of over or under exposure it is a fairly safe rule to boldly halve or double the exposure, as indicated by the state of the plate on development, and not to try intermediate differences of time. Perhaps a few examples of exposures taken from my own record book may be some little guide to an absolute beginner. Thus, with lamp-light and a Herschel auxiliary condenser, in addition to the sub-stage condenser, without screens, with a projection eyepiece x3, and a moderate camera length, a 1-inch objective required 45 seconds exposure, and a $\frac{1}{6}$-inch objective about three minutes; whilst with the oxy-hydrogen light and a Conrady achromatic and aplanatic condenser, a 1-inch objective required 10 seconds, and a $\frac{1}{4}$-inch 45 seconds. The use of screens would double or treble these exposures, and the nature of the object may also make much difference.

The developers differ somewhat from ordinary photography, as we require not soft graduations, but sharp blacks and whites. The best developer I know of for this purpose is metol and hydroquinone, but for particulars as to the use of this I must refer the reader to ordinary books on photography, merely observing that development should be carried beyond the stage required for ordinary work. Whatever developer is used, however, it should be mastered and adhered to as a general rule. Intensification and reduction are valuable aids in modifying or improving otherwise unsatisfactory negatives.

The best paper is a Bromide paper, amongst which "Nikko" is excellent for our purpose. Printing-out papers are less satisfactory, especially for reproductive work for the press, but are capable of being watched and humoured rather more, and are useful also for rough trials.

These notes have already run to a greater length than I originally intended, but I have tried to keep them as elementary as possible, and to refrain from going into too much detail, though it has been a constant temptation to enlarge on the many important points dealt with. I hope I have, however, explained the essential points which a beginner needs to know.*

Royal Microscopical Society.

April 18—J. C. Karop, Esq., M.R.C.S., Vice-President, in the chair. Dr. Hebb exhibited and described a simple and effective form of apparatus for obtaining blood for bacteriological examination and cultivation. He also showed some cultures of bacteria on blood serum and agar, which were preserved in formalin. The cultures were killed, and at the same time mounted, by pouring into the test-tube 10 per cent. formalin on the top of which was placed a mixture of melted paraffin and vaseline. When cool, this formed an air-tight and stable cylindrical stopper. Dr. Hebb remarked that the method was not adapted for all cultures, as some were dissolved off the surface by the preservative fluid. Dr. Hebb also exhibited some test-tubes containing sterilised nutrient broth plugged in the same way. The object of the plug was to allow the tubes to be transported from place to place without damage to or loss of the medium. To remove the plug it was only necessary to warm the tube. A series of coloured lantern slides of botanical sections by Mr. Flatters, of Manchester, were shown.

Quekett Microscopical Club.

April 20—the President in the chair. The Hon. Editor, Mr. F. P. Smith, brought forward two papers. The first, "On the Spiders of the *Diplocephalus* Group," concluded the revision of the British species of the subfamily Erigoninæ. The second paper was a catalogue of the literature dealing with Erigonine spiders.

Mr. H. Taverner, F.R.M.S., gave an account of the methods he employed in stereo-photomicrography. The axial rays were found to be detrimental to the formation of a stereoscopic image, and after considerable experiment a form of Davis's shutter is now employed, fitted above the objective and able to be shifted by screw adjustment to a maximum of 4 mm. either side of the optic axis. To obviate cutting the prints for mounting, a repeating back is used and the image received on the left half of the plate, with the aperture of the stop to the left of the optic axis, and the second exposure on the right half of the plate with stop to the right of the optic axis. The diameter of the aperture was usually $2\frac{1}{2}$ mm., with its inner edge not more than 1 mm. from the optic axis.

The Hon. Secretary read a paper on the same subject by Mr. W. R. Dollman. Only low powers are used—photo objectives with focal lengths of from two to six inches being employed. A semi-circular shield is placed against the diaphragm between the combinations and rotated through 180° between the two exposures. Acetylene is used as illuminant.

Mr. J. Rheinberg, F.R.M.S., read a long and technical paper dealing with "Stereoscopic Effect, and a

* The first instalment appeared in "KNOWLEDGE," for November, 1905.

Suggested Improvement in Binocular Microscopes." It was shown that by means of a stop with circular apertures placed between the objective and the prisms in an ordinary binocular, definition was greatly improved. Wenham and Stevenson forms of binocular microscopes were exhibited with and without the stops suggested. A Greenough binocular with separate objectives and a stand fitted with the Abbe stereoscopic eyepiece were also on the table.

Creosote as a dehydrating medium for embedding in Paraffin.

W. Pavlow recommends the following method of dehydrating tissues prior to embedding in paraffin, instead of the usual method with alcohol: The objects may be fixed in any kind of fluid, and are then transferred, without any other previous dehydration, to creosotum fagi for 4 to 24 hours, according to their size, and finally put into pure creosote for two or three hours longer. On removal the superfluous creosote is taken up with blotting paper, the objects are soaked in xylol or toluol for an hour, and then embedded in paraffin as usual.

Carl Zeiss' New Catalogue.

The 33rd edition of Messrs. Zeiss' new catalogue has just been issued and shows certain modifications from former editions, more especially with regard to microscope stands, certain models having been withdrawn, and others added. To their larger stands Messrs. Zeiss fit their new "Berger" form of micrometer fine adjustment, which is a great improvement on the older form, the consequent alteration in the limb enabling them to add also a convenient, yet unobtrusive, handle for lifting the microscope. The provision of such a handle is, however, even more necessary in the older form of microscope where the whole limb, instead of being fixed as in the above models, is borne upon the upright triangular bar of the fine adjustment, for it is by this limb that the average student persists in lifting his microscope. A new upright stand for rough laboratory use has been added, which is fitted with a coarse adjustment only, corresponding to similar stands made by Leitz and other makers. Perhaps of even more interest, however, to the general microscopist is the fact that in the present catalogue Messrs. Zeiss have considerably reduced the prices of many of their achromatic objectives, the old D of ½-inch focal length, for instance, being reduced from £2 2s. to £1 15s., and the 1-12th inch oil immersion from £8 to £6 5s. The Huygenian oculars, nose-pieces, &c., show corresponding reductions. The apo-chromatic objectives and compensating oculars, unfortunately, are not reduced in price, and amongst the former we note that the one inch of .3 N.A., formerly supplied for the 10-inch tube, no longer appears. Apart from its own interest, the catalogue contains much valuable information on optical matters, set forth in a lucid and instructive manner, but I regret to see that Messrs. Zeiss continue (on page 19) to give inaccurate magnifications for the compensating oculars as used for the Continental length of tube, and to state that when these are used for the 10-inch tube "to obtain correct *ocular* magnification (the italics are my own) it is necessary to multiply the figures engraved on the oculars by 1.5." Of course, the ocular magnification does not vary at all under such circumstances, and it is the objective magnification that needs to be multiplied by 1.5, the total magnification of ocular plus objective giving the same result whichever method of working be adopted. The practical disadvantages of the former system are that it leads to much confusion of thought—as only those who, like myself, have frequently to answer questions on the subject fully realise—that it is incorrect, and, therefore, unscientific, and that it causes a worker to underrate by 50 per cent. the power of the ocular which he is using and the consequent strain which he is putting upon his objective. I hope that in the next edition of the catalogue this small, but not unimportant, matter will receive attention.

Microscopical Material.

Mr. W. S. Rogers, of Slough, is good enough to send me for distribution some shore scrapings from Adelaide, South Australia. The quantity is, unfortunately, limited, but I shall be glad to send some to the first applicants who send me a stamped and addressed envelope, and a very *small* box, to prevent crushing of the shells. Applications must be accompanied by the coupon to be found in the advertisement pages of this issue, and as I can only supply the first-comers in rotation until the material is exhausted it will be seen that early application is necessary. I shall, however, keep a small quantity for foreign readers. I am always grateful for any microscopical material for distribution, and hope that any of my readers who can assist me in this way will do so.

Notes and Queries.

Diatomaceous Deposit.—Mr. T. W. Robertson, Glasgow, who is much interested in diatoms, would be grateful if any reader could assist him to get some diatomaceous deposit from the province of Simbrisk, Russia, and from Sendai, Japan. Mr. Robertson would be glad to defray any expense, or to know of anyone likely to supply his wants.

Volcanic Dust from Mont Pelée Eruption.—The Rev. W. Hamilton Gordon, Fareham, Hants., would be glad if any reader could give him any information as to the requisite treatment for volcanic dust, and as to what points of interest there are in such dust.

Mounting Diatoms in Realgar.—Replying to W. H. B., Leicester, Mr. Basil F. T. Tryon kindly sends me the following, echoed from an article by Mr. J. W. Gifford in the "Illustrated Annual of Microscopy" for 1898: "Realgar is prepared by heating together equal parts of clear red realgar and stick brimstone (flour sulphur is apt to be full of dust). In order to prepare the mount a drop of the solution containing the diatoms must be dried on a very thin cover-glass by passing it, diatoms uppermost, through the flame of a spirit lamp. A small piece of the medium is then placed on the glass slide, which is carefully warmed in the same way by passing to and fro through the flame until the medium melts, and while both are still in the flame of the lamp, the cover is turned over and carefully lowered until contact is made with the medium. As soon as it has spread out to the edges a clip must be put on, or the medium will crack off in cooling, which must take place very gradually. The best thing is to put the mount, still hot, into a small tin box, previously warmed, and place the whole in a vessel of boiling water and put aside to cool. The water must, of course, not touch the mount. There will be many failures; but when a good mount is made it will be well worth the pains taken. This medium is very yellow, but this is no objection." Mr. Tryon adds, "I have been told that the making of realgar mounts is very dangerous, on account of the arsenic fumes given off in heating. They should be prepared in the open air and in fine weather. Damp ruins them. Ring with Hollis' glue."

C.M., Tunbridge Wells.—I am informed that the fungi in the slide you have sent me are *Triposporium elegans*, one of the Dematieæ. They have apparently not been yet worked out and are consequently put amongst the Fungi Imperfecti, whose life history is not known.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for June.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.51 and sets at 8.4; on the 30th he rises at 3.48 and sets at 8.18.

Summer commences on the 22nd, when the Sun enters the sign of Cancer at 9 a.m.; this is the longest day, the Sun being $16^h\ 34^m$ above the horizon. The equation of time is negligible on the 15th, hence this is a convenient day for adjusting sundials, as only the correction for longitude is needed. Sunspots and prominences appear to be slightly on the wane, but at this period of solar activity the disc is rarely devoid of spots.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. or N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 31 ..	16° 12′ W	0° 37′ S	96° 58′
June 5 ..	14° 18′ W	0° 1′ S	30° 48′
,, 10 ..	12° 18′ W	0° 35′ N	324° 38′
,, 15 ..	10° 12′ W	1° 12′ N	258° 28′
,, 20 ..	8° 1′ W	1° 47′ N	192° 15′
,, 25 ..	5° 48′ W	2° 21′ N	126° 5′
,, 30 ..	3° 32′ W	2° 55′ N	59° 54′

THE MOON:—

Date.	Phases.	H. M.
June 6 ..	○ Full Moon	9 12 p.m.
,, 13 ..	☾ Last Quarter	7 34 p.m.
,, 21 ..	● New Moon	11 6 p.m.
,, 29 ..	☽ First Quarter	2 19 p.m.
,, 6 ..	Perigee	5 12 a.m.
,, 18 ..	Apogee	10 12 p.m.

OCCULTATIONS.—The following occultations are visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p.m.		p.m.	
June 5	49 Librae	5·6	7.57	125°	9.0	276°
,, 7	μ Sagittarii ..	4·0	10.45	116°	11.51	259°

THE PLANETS.—Mercury (June 1, R.A. $3^h\ 56^m$; Dec. N. 19° 57′. June 30, R.A. $8^h\ 8^m$; Dec. N. 21° 53′) is in superior conjunction with the sun on the 8th, and hence the planet is unobservable. Towards the end of the month the planet is an evening star in Gemini, and may be observed immediately after sunset low down in the N.W.; on the 25th the plant sets at 9.40 p.m. or $1^h\ 20^m$ after the Sun.

Venus (June 1, R.A. $6^h\ 31^m$; Dec. N. 24° 44′; June 30, R.A. $8^h\ 59^m$; Dec. N. 19° 2′) is an evening star in Gemini, setting about 2 hours after the Sun throughout the month. The planet is pretty bright and should be looked for shortly after sunset, itwill be found in that portion of the sky illuminated by the afterglow of the setting Sun.

The apparent diameter of the disc is 12″·5 and it appears gibbous, 0·84 being illuminated.

On the evening of the 24th the planet will appear in proximity to the crescent Moon, Venus being 2½° to the north.

Mars (June 1, R.A. $5^h\ 30^m$; Dec. N. 24° 3′. June 30, R.A. $6^h\ 54^m$; Dec. N. 23° 49′) is practically unobservable as he sets very shortly after the Sun.

Jupiter (June 1, R.A. $5^h\ 2^m$; Dec. N. 22° 23′; June 30, R.A. $5^h\ 31^m$; Dec. N. 22° 56′) is in conjunction with the Sun on the 10th, hence the planet is unobservable.

Saturn (June 1, R.A. $23^h\ 6^m$; Dec. S. 7° 44′. June 30, R.A. $23^h\ 8^m$; Dec. S. 7° 39′) is a morning star, rising about midnight near the middle of the month. The planet is at the stationary point on the 27th, after which date he continues to describe a retrograde path in Aquarius for the next four months.

Uranus (June 15, R.A. $18^h\ 31^m$; Dec. S. 23° 35′) rises about 9 p.m. near the middle of the month, and is on the meridian about 1 a.m. The planet is in opposition on the 29th, but he is not well placed for observation as he is situated low down in Sagittarius.

Neptune (June 15, R.A. $6^h\ 41^m$; Dec. N. 22° 14′) is out of range for observation, as early next month he is in conjunction with the Sun.

METEOR SHOWERS:—

Date.	Radiant.		Name.	Characteristics.
	R.A.	Dec.		
	h. m.			
June—July..	16 48	−21°	α Scorpiids	Fireballs.
June 13 ..	20 40	+61°	α Cepheids	Streaks, swift.

TELESCOPIC OBJECTS:—

DOUBLE STARS, &c.— Scorpii, XVI.^{h} 0^m, S. 19° 33′, mags. 2·7, 5·2; separation 13″·1.

ε Lyræ, XVIII.^{h} 41^m, N. 39° 33′, known as the "double-double" star, can just be separated by the naked eye, but with a pair of opera glasses it is readily divided into two components ϵ_1 and ϵ_2, mags. 4·4 and 4·8. Using a 3-in. telescope and a power of about 120, each of these stars can again be divided into pairs, 3″·2 and 2″·6 apart respectively, each component being about magnitude 5·5.

M 57 (Lyra), the "ring" nebula. This nebula is the only annular nebula accessible to telescopes of about 3-in. aperture, and even then requires good seeing. It is easily found, being situated about ⅛ of the distance from β to γ Lyræ. The usual appearance in a 3-in. telescope is that of a rather large nebulous star, but it bears magnification well, and its annular character can easily be made out with a moderately high power.

M 80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.

Temperature of the Hemispheres.

THE Southern Hemisphere as a whole is colder than the Northern Hemisphere, and a new determination of the mean temperatures has been made by M. Julius Hann in the *Lehrbuch der Meteorologie*. In Southern latitudes the annual temperature varies from 5·5 deg. C. in Lat. 50 deg. to 20 deg. below freezing in Lat. 80 deg. The mean annual temperature of the Southern Hemisphere is 13·6 deg. C., and ranges from 17·3 deg. in January to 10·3 deg. in July. In the Northern Hemisphere the mean annual temperature is 15·2 deg. C., and ranges from 8 deg. C. in January to 22·5 deg. C. in July. In the higher latitudes the differences of temperature seem to be accentuated in the direction of a general lower temperature for the South. The mean annual difference of temperature between the two Hemispheres is about 1·5 deg. C.